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Preface

Although Taiwan is situated on the edge of the tropics, four major types of communities including tropical, subtropical, temperate and alpine types were observed on this island due to wide range in altitude. Thus both the flora and fauna are extremely rich. However, Taiwan is a relatively small island with the highest population density in the world. Human activities and development projects have exerted great stress on the environment as well as wildlifes. Species of wildlifes have been diminishing over the years, and it became urgent to protect the endangered species and establish ideas and policies on wildlife conservation. Many governmental programs on wildlife are in progress and the public awareness on ecology issues have been increasing. Experiences of researches from more advanced countries are needed for improvement in our nature conservation researches and techniques as well as the training of more wildlife biologists. The "International Symposium on Wildlife Conservation" was then held at the International Conference Hall of Academia Sinica in Taipei between 25-29, March, 1991. During the meeting 17 papers were presented by delegates from Japan, the United States of America and the Republic of China. This symposium was made possible with the help and support of many people and agencies. First of all, I thank all the participants of more than 230 people who either presented papers or participated in discussions. Thanks are also due to the Council of Agriculture for providing financial aids to this symposium, the Taiwan Forest Bureau and Yu Shan National Park for their hospitality and arrangement of the field trip.

Yao-Sung Lin

Convenor

Taipei, 1991.

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WILDLIFE MANAGEMENT: A PERSPECTIVE ON AN INTERNATIONAL RESOURCE NECESSITY

Jack H. Berryman

Abstract. The paper presents a fish and wildlife management perspective in the United States and its relationship to similar issues in other nations. It stresses the importance of sound balanced management. It describes the history and current status of fish and wildlife management in the United States and cites habitat problems, the anti-management movement, and inadequate funding as the major problems. It mentions the negative impact of anti-management activities in several countries and cites the positive example of Taiwan in its efforts to develop a balanced management approach. It concludes with the point that the protection of habitat and the future of wildlife resources can only be assured through rational management and that sound management must be compatible with other human requirement.

It is a privilege to participate in this International Conference and I commend its sponsorship by the National Taiwan University and the Council of Agriculture. It is most timely with increasing global environmental concerns -- and with strong disagreements on their nature and solutions.

My wife, June, and I had the good fortune to visit Taiwan in 1986 and get acquainted with many of the issues and people involved in various aspects of resource management. We were greatly impressed with the competence and dedication of the professionals; the work of the cooperators; the efforts to develop sound laws; and the vigor, determination and optimism of all concerned. It is very good to be back!

It is my purpose to briefly describe a philosophic and management perspective of fish and wildlife resource management in the United States and the relationship to similar issues in many other nations.

At the outset, let me state my personal philosophy and the objectives of the International Asociation of Fish and Wildlife Agencies. I am strongly committed to the concept of rational and balanced resource management, including the protection, conservation and use of fish and wildlife resources, whether that use be for subsistence, for hunting, fishing, or other recreation, or for commercial, economic, or control purpose -- always with the proviso that any of the uses do not threaten the future of any plant or animal species. And, that wildlife management must be integrated into the fabric of society's overall needs. The various needs of wildlife and people can be satisfied only through management. Indeed, it is the very purpose of management. I believe strongly that the future of wildlife resources can be assured only through wise management and use.

That philosophy closely parallels the objectives of the International Association which are, among other things: to encourage and promote sound resource management; to foster a public understanding of the need for such management; and to promote cooperation and international arrangements to achieve such management.

The International Association, founded in 1902, includes all 50 state fish and wildlife managing agencies, and the provincial and federal agencies of the United States, Canada and Mexico. The Republic of China is the only non-Western Hemisphere representative. The Association has been pleased to have it as a Cooperating Member and active participant since 1983.

With all 50 states as members, the Association is, as you might expect, vitally and directly concerned and involved with issues affecting fish and wildlife resources in North America and elsewhere.

Modern day wildlife management in the United States is a product of our history, colonization, western expansion and the current situation. At the time of colonization, beginning in the 1600's, fish and wildlife, in fact all resources, were plentiful --there for the taking and use by the people. And, that included all of the people. The colonists and settlers were determined to avoid the European notion that game was for the privileged few. That determination has been legalized and institutionalized. Fish and wildlife resources belong to the people, not to the government; and to all of the people, not just the hunters and fishermen. Fish and wildlife resources are held in trust by the government for the benefit of the people. Today, every citizen may obtain a license to fish or hunt -- a right that is vigorously defended. Public ownership and use is a proud heritage but brings problems and responsibilities.

As the continent was explored and colonized and state and local governments were formed, and as the population increased, it became apparent that fish and wildlife resources needed protection and regulation. And, by the time the westward expansion reached the Pacific Coast, the long period of virtually unrestricted resource exploitation began to give way to a period of conservation and management -- the establishment of conservation organizations, the passage of laws, the creation of agencies and the reservation of lands.

Today, almost one third of the Nation is in some form of public ownership. There are 272 million acres of public land administered by the bureau of Land Management; 191 million acres in the National Forest System; 80.1 million acres in National Parks; and 91 million acres in National Wildlife Refuges. Collectively, 93.1 million acres of these lands are designated as wilderness. Additionally, there are similar kinds of state-owned lands in virtually all states. With the exception of the National Parks, there are wildlife management programs on these lands and most are open to regulated public hunting and fishing. And, most private lands are also available for public hunting under a variety of conditions.

According to a 1985 survey(1), 63.1 million Americans hunted or fished and spent $38.2 billion for their activities; and, 134.7 million people participated in some form of wildlife-oriented recreation and spent $14.3 billion. Obviously some did both. Clearly fish and wildlife resources provide enjoyment to many and have a significant impace on local and national economies.

The heritage of public hunting and fishing and the pattern of land ownership and use that has evolved in the United States has been instrumental in the evolution and administration of fish and wildlife agencies. Initially, the managing agencies were concerned primarily with the game species; their primary constituents were fishermen and hunters; and, their main source of revenue was from fishing and hunting licenses. With an increase in the population and demands upon resources, with research, with sophistication of knowledge and methodology, increasing public awareness, broader legislative mandates and additional functions, and with broader sources of revenue, most of today's fish and wildlife agencies have

(1) 1985 National Survey of Fishing, Huntiag and Wildlife Associated Recreation. U.S. Fish and Wildlife Service, U.S. Department of Interion, November 1988.

become broad gauge resource organizations interested in and responsible for game and non-game forms alike, including endangered species. Today there are highly qualified, competent agencies in all 50 U.S. states, the Federal Government, and the Canadian Provinces, Territories and Federal Government, staffed by well-trained professional. The Wildlife Society, the professional society for wildlife workers, and the American Fisheries Society for fishery workers, now have 8200 and 8500 members respectively.

In our system of shared responsibility, the Federal Government has responsibility for migratory and endangered species and the states for the so-called resident species.

We are fortunate in North America. We have a wide variety and an abundance of fish and wildlife resources. We enjoy fishing and hunting and there is increasing interest in the well being of non-game forms. We have good laws, good agencies, good working relationships and good international arrangements. And, we have strong non-governmental organizations and a very aware public. That is not to say that we do not have problems in each of these areas -- some serious.

The two greatest problems facing U.S. agencies are: first, continued habitat loss, degradation or modification; and secondly, a strong anti-management, anti-use, preservationist philosophy and movement that actively challenges sound and necessary management and the human use of wildlife resources and all other animals. And, there is always the problem of inadequate funding, aggravated by an austere fiscal climate.

Our habitat problems are caused by residential and industrial expansion, contaminants, increasing demands for food and fiber, and resultant changes in land use -- all driven by an increasing human population and a foreign policy of developing or permitting new markets, especially for agricultural, forestry and fishery products.

It seems obvious to me -- imperative, in fact -- that the solution to our resource problems is through sound balanced management which must be developed within the framework of overall human requirements and economic and social conditions. This means that management -- sound management programs must be compatible with other human needs and requirements.

It is at the point of solution where we in the U.S. run into philosophical difficulties. The anti-management, anti-use and preservationist forces would halt management, even use. And, the animal rights activists place animal rights on an equal basis with human rights and needs.

These "anti" forces have emotional appeal, especially among an increasing urban population, removed from an exposure to wild animals, and they employ very sophisticated legal, legislative and public relations techniques. They have scored some significant successes.

My point is that those who espouse the anti-management philosophy in the U.S., under the misdirected premise of animal welfare and resource conservation, are serving to thwart the sound management programs that are absolutely necessary to the long-range survival and well being of wildlife resources.

So it is in other places. The "anti" movement is spreading and gaining ground. I am, of course, aware that the resource problems in various lands and the search for solutions stem from differing historical and cultural backgrounds; economic and social conditions; and the current status of resources. And, while we are fortunate in the United States, I think our problems of habitat and philosophy are replicated in many other places in the world.

I was surprised to learn that an anti-fur movement has begun here in Taiwan which culturally and traditionally is consumer or use oriented.

In Canada, protectionist forces wreaked havoc with the sealing industry with grave consequences, not only for successful seal management, but with very serious social and economic consequences for the native populations that depended upon seals -- and who lived in harmony with the seals. And, with negative impacts on related and dependent businesses, all of which supported seal management. The same "anti" forces in the U.S. halted extension of the Northern Pacific Fur Seal Convention.

June and I have visited with the native peoples in the Canadian Territories and are much aware of their significant dependence upon fish and wildlife and their products -- and of their basic traditional interest in conservation. Fishing, hunting, trapping, native crafts and wildlife related tourism are of tremendous social and economic importance to all of Canada and serve as an incentive to maintain these resources in healthy conditions.

In Europe some member of the European Community, pressured by the animal rights activists, are attempting to halt the sale of furs taken by traps. Clearly that action would have a very negative impact on furbearer management in the United States and Canada and economically upon those who depend upon fur resources for a part of their livelihood. In England especially, the protests of the animal rightists have become increasingly violent and terroristic -- to the point that they have the concern of Scotland Yard.

In Southern Africa, wildlife is confronted with a variety of problems. And, it will not be sufficient to focus on single spectacular species or isolated parks to preserve and maintain the rich wildlife heritage of that unique area. That will result only in the preservation of outdoor museum pieces. June and I learned at first hand of the importance of intensive management, including the development of economic incentives, shared by the native peoples so that wildlife becomes an asset to be protected, valued and managed rather than a nuisance or liability.

During our 1986 visit to Taiwan, we became very much aware of the difficulty in achieving its progressive wildlife conservation goals in the face of its long cultural history, its high population and the necessity of continued economic growth. With some 6% of its land area in National parks; with the determination to save the landlocked salmon, the Formosan magpie and other endangered species; and its dependence on aquaculture and marine resources, Taiwan must have a balanced approach, including responsible use.

It is indeed a challenge and the leadership of Taiwan has shown great wisdom by including the entire governmental structure, academia, conservation and commercial interests, along with its professional staff, in developing a plan. And, final passage and adoption of the Wildlife Law sets the stage for its implementation.

I think this approach will stand as an example for all of the Asiatic countries with very dense human populations and needs, with a long culture of unrestricted individual use of fish and wildlife resources. Obviously conservation, management and responsible use of fish and wildlife resources can be accomplished only with the education, understanding and support of the public at large.

The point I wish to make is that the protection of habitat and the future of wildlife resources can be assured only through rational management and a rejection of the simplistic solutions espoused by the animal rightists and the preservationists. A wise member of the U.S. Congress once advised a conservation audience, "We are not going to lock up this Nation's resources nor permit their unregulated exploitation." Very wise counsel and appropriate to this discussions.

Management does not operate in a vacuum. It includes protection -- absolute where necessary, research, law enforcement, land acquisition and development, education -- and harvest. It also includes the development of the necessary laws and institutions and the inclusion of wildlife concerns in the development of economic and agricultural policies. Management must be compatible with other human requirements.

I believe this to be valid whether we are dealing with deforestation in South America; Monarch butterflies in Mexico; elephants in Africa; marine mammals, salmon and tuna in the seas; or migratory waterfowl in North America. And it is also valid whether the motivation stems from hunting, trapping, subsistence, commercial use or protection.

Fish and wildlife resources the world over are under increasing pressures of many kinds, including the loss of habitat. Their future, including the protection and restoration of endangered forms, demands a variety of imaginative, broad gauge management plans and programs.

Ironically, the animal rights and preservationist movements are gaining ground, undermining urgently needed responsible management programs. The International Association of Fish and Wildlife Agencies has established a "Proactive Strategy Project" to deal with "anti" movement -- not simply to react, but to develop a long-range strategy for supporting management in positive ways in the U.S. and Canada.

I hope that one result of this symposium will be to recognize this "anti" movement and to support much needed sound, rational management.

Thank you.

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REFUGES AND ZONING TO CONTROL EXPLOITATION OF HUNTED WILDLIFE

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Abstract. Developing countries look to North America and Europe for guidance on how to implement wildlife conservation and solve management problems. Harvests of huntable wildlife in North America and Europe are based on regulations on seasons, bag limits, hunting hours, etc. This approach assumes that reliable information is available to set reasonable regulations, and that hunter compliance can be achieved. These assumptions often cannot be met in countries where wildlife management is in early stages because little biological data are available, habitats are dense, and hunter compliance is not assured. A system of zoning and refuges to control hunting of harvestable species is outlined that may be more feasible in these cases. Strategies of securing preservation and sustained yield through zoning and refuges are outlined. It is noted that North America and Europe made similar use of refuges in their evolution towards control of harvests by regulations.

INTRODUCTION

In the developed world, wildlife management is predicated upon habitat management and hunting programs that depend upon sound biological information. Habitats are assessed and measures imposed to achieve improvements to benefit wildlife of the desired kinds. Hunting seasons, methods, and bag limits are based upon population assessments. These systems of management have had a long period of development as research gave information necessary to support such approaches, and social change came about in public attitudes and policies. It should be noted that most of these programs were initiated because lack of control resulted in reduction and extirpation of wildlife. The management systems we see today were those necessary for restoration of wildlife habitats and populations.

It is natural that developing nations should look to such wildlife programs for modesl of how they could manage their threatened environments and wildlife populations. In other cases, such as Taiwan, economic development has been achieved, but wildlife management remains in early stages. There is little argument that the long term goal of wildlife management in developing areas is a safeguarding of habitats and preservation of wildlife populations for the long-term benefit of society. These benefits include aesthetics, recreation, and sutained harvests of expolitable species. However, in the short terms, the information upon which to base such a program is lacking. There are few trained people, and not much budget to support gathering of the necessary data. Furthermore, much of the developing world is in tropical regions where dense cover makes population assessement extremely difficult, and where many methods useful in temperate zones cannot be applied.

Besides the lack of information, often the hunters are not supportive of management programs. Local subsistence economics are driven by current need; thus, long-term sustainability, although desirable, may seem like an unaffordable luxury. There also may be a market for game meat or other products that motivates hunting. In addition, hunting may have traditional and cultural values that encourage continuance.

In the absence of solid population data it is hard to show that subsistence hunting is having an adverse impact on wildlife populations.

How is wildlife conservation to be achieved given this situation? What approaches can be applied until appropriate information is generated to support management like that in developed countries? Clearly a different approach is necessary for the interim period.

ZONING AND REFUGES

Total protection from hunting is an easily understood concept. It has been applied to endangered species, where a harvest is to be avoided, and to parks and reserves where intact natural ecosystems are to be saved as a whole. However, refuges, as a system of controls for species that can sustain a harvest, particularly where a subsistence harvest is important for justifying wildlife conservation, have not been developed. Historically, control of hunting and establishing refuges are some of the first means of preserving wildlife. Leopold (1933), in his seminal book, *Game Management*, included an entire chapter on refuges. In North America, with the exception of endangered species and migratory waterfowl, and a few other cases, refuges became secondary to controlling harvest as more information-based systems were developed.

Elsewhere I have proposed that refuges may be the most feasible way to deal with managing exploited wildlife populations in the absence of information to implement information-based management systems (McCullough 1990). I established the theoretical basis for the use of a system of refuges to meet population management objectives. Assuming that refuges can be given effective protection, such a system can be used to avoid extirpation. Also, I proposed the rational and a strategy for achieving maximum sustainable yield (MSY) with the only requirement for data being an estimate of the kill.

THE BASIC CONCEPT

The concept can be illustrated by a simple example. Assume the area to be managed is square, and can be divided into a series of smaller squares in a grid, each large enough to maintain a minimum viable population. Then assume that a small number of squares are open for hunting, while the remainder are protected from hunting. Hunting may remove all or part of the population from the hunted squares. If all of the population is taken, the future hunting harvest will be based upon the dispersal of animals from the adjacent protected squares. If only part of the population is removed, then subsequent hunting harvest will be composed of both production from within the hunted squares as well as dispersal from the adjacent protected squares. After a few years, harvest should stabilize based upon the replenishment rate of the hunted squares from the two sources. The harvest should stabilize, not in the sense of constant numbers, but rather variable within a reasonable range.

Next, an additional set of squares can be opened for hunting with the remaining squares continuing to be protected from hunting. an increase in harvest should follow if relatively few of the total number of square are subjected to hunting. Again, a relative stabilization of harvest over time would be expected.

By iterations of this process, an increasing proportion of the squares can be opened to harvest with a declining proportion receiving total protection. The total harvest should increase as harvests are less than the population in the total area can replace, but decline when harvest size exceeds the replacement. Even though overhunting results in reduced harvest, the population is prevented from sliding to extinction because of the continuing protection afforded by the unhunted squares.

The relationship of harvest to number of squares open to hunting would

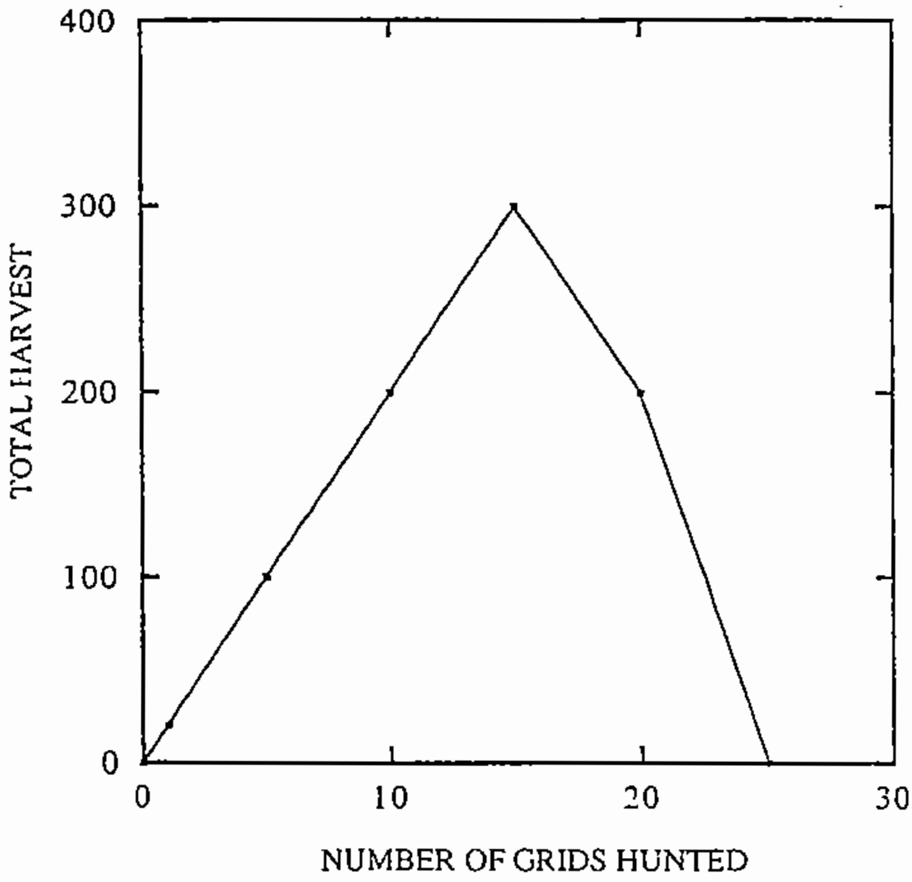

Fig. 1. Expected relationship between number of squares hunted in a hypothetical gridded area and the total harvest from the total area. As the number of hunted squares is increased, the harvest should increase until too many squares are hunted (i.e., too much hunting pressure is placed on the population over the total area) at which point the harvest should decline. The remaining protected squares should prevent extinction even if overharvest (in the sense of maximum yield) occurs.

be expected to be a parabola (Figure 1). The shape of the parabola might not be symmetrical, but rather skewed in one direction or the other depending upon the size of the squares in relationship to habitat patchiness, dispersal distances and tendencies, and other aspects of the biology of the species. The harvest rate per hunted square (Figure 2) would necessarily be a declining function (although the shape would vary with skew of the total harvest function) because the two graphs are simply two different ways of displaying the same relationship. Although this example uses an iteration process starting with full protection and working towards progressive opening to hunting, the same approach on number of squares hunted could as well start from the whole area open to hunting and work progressively towards protection.

Note that Figure 1 is analogous to the recruitment numbers on population size graph and Figure 2 is analogous to the recruitment rate on population size

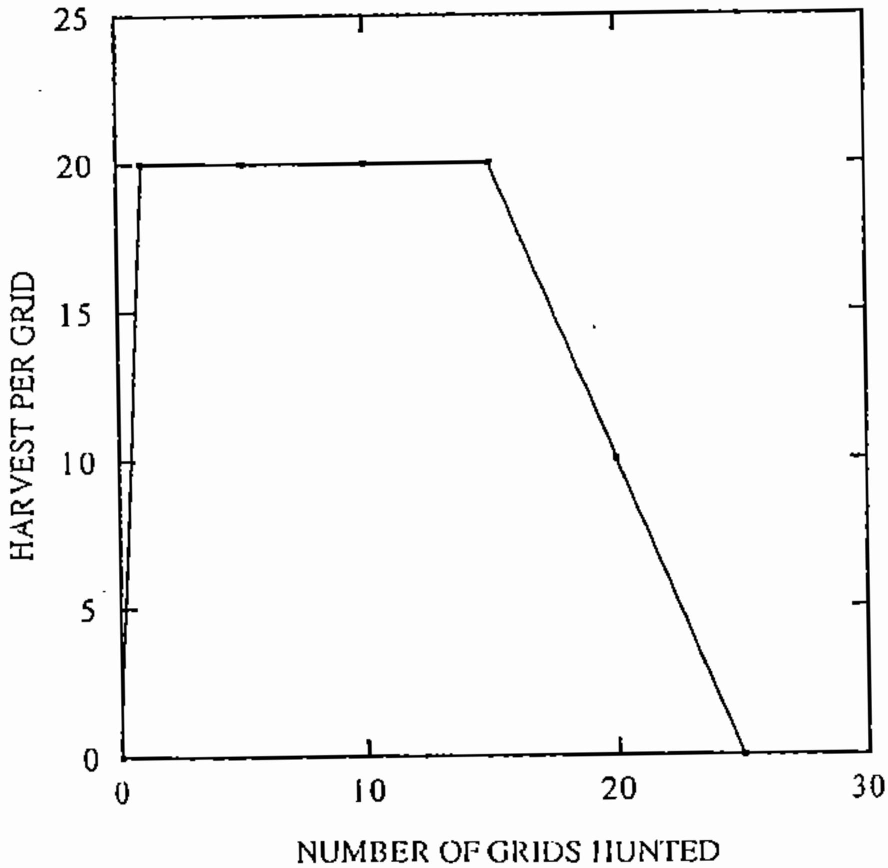

Fig. 2. Expected relationship between number of squares hunted in a hypothetical gridded area and the harvest per hunted square, as derived from Figure1.

graph of conventional models of population response to harvest by controlling regulations on a common area (McCullough 1979, Fig. 6.6, page 100; Fig 65, page 99). This illustrated that spatial management of harvest through protected and hunted areas is closely related to controlled harvest through regulations on hunters over the total area. The process is somewhat different in that in the former, spatial elements of productivity and dispersal behavior determine harvest, whereas in the latter, numerical elements interacting with regulations determine harvest. Nevertheless, the basic thinking about impacts of the harvest program on the population are nearly identical.

ADVANTAGES OF SPATIAL HARVEST CONTROL

What are some of the advantages of the spatial management model? First, and most important, is its relative lack of requirement for population data. The only data requirement is for an estimation of the harvest. In fact, at minimum one need know only whether the harvest increased or decreased with each change in the iterative, trial-and-error shift in number of squares harvested. One can obtain maximum sustainable yield, or a given yield from a low or high population through the trial-and-error iterations.

Second, spatial management is resistant to unintended overharvest inadvertently reducing population size (potentially to extinction) through errors in population data. Because the population is protected by continuously unhunted areas, the remaining protection remains in effect, even if harvests greater than MSY are taken. In contrast, populations that are managed by regulations may slide precipitously downward if MSY is exceeded, and the error is not discovered quickly. This characteristic accounts for the widespread disillusionment with MSY as a management goal (Larkin 1977, Holt and Talbot 1978). Lancia et al. (1988) have pointed out that proportional harvests can solve this problem because they self-correct for harvests greater than MSY. Nevertheless, this approach requires that population size be estimated reasonably, and thus, requires good population data.

APPLYING SPATIAL MANAGEMENT IN THE REAL WORLD

The advantages of spatial management outlined above are sufficient that in cases where population data requirements cannot be met, it should be considered as an alternative model for management of wildlife harvest. These conditions occur where programs do not exist, and where habitats are such that population data are difficult or impossible to generate. Certainly it is not a cure-all for population management. The idealized case used above to illustrate the concept never will occure in the real world, where variation due to topography, climate, vegetation, and human influences is extreme. The translation of the concept to a workable plan in a given landscape will tax the imagination and ingenuity of the manager. And, as with management by regulation, this approach depends upon the willingness of hunters to comply with the requirements of the program or the ability of the management agency to enforce those requirements. For protected areas to work, the boundaries must be recognizable in the field under conditions in which hunting is conducted, and hunters must be willing to comply or be forced by policing efforts to comply with closed areas.

A POTENTIAL EXAMPLE: HOKKAIDO, JAPAN

Consider some cases where refuges might be used to achieve population management goals. Recently I had opportunity to visit Hokkaido, the north island of Japan. Japanese scientists are concerned about the apparent decline in the native brown bear (*Ursus arctos*), population due to huntintg, and the increase in the native sika deer (*Cervus nippon*) population with consequent increase in crop and forest damages (Ohtaishi, et al. 1990). Hunting is a long-held tradition and is practiced with little in the way of regulation. Among hunters, the right to hunt without interference is assumed. there is little in the way of a governmental infrastructure to carry out management. The biologists are highly capable, but there are few of them, funds are scarce, and the island has a vast extent of wild landscape, mostly covered by dense forests that make population assessment extremely difficult.

Initiatives are now being taken to establish an infrastructure with adequate authority and budget to conduct wildlife management programs. Such changes will take a considerable time. Although Japan has been a developed nation economically for some time, the need for governmental control of wildlife management and the commitment to political and funding requirements are only beginning to be acknowledged. Once wildlife management is established, it will be many more years before an adequate data base can be assembled to put forward regulations by which harvest control can be achieved by this approach. the problem is complicated by the fact that hunting on one species, brown bear, needs to be reduced, whereas hunting on the other, sika deer, needs to be increased. Meanwhile, the problem grows worse. What can be done in the meantime until better data and better controls are available?

As outlined earlier, this situation matches the circumstances in which a zoning and refuge system can be the most effective short-term means of reaching population goals. The evolution of wildlife management in Hokkaido will have to occur along lines that are similar to those that occurred in North America and europe, and refuges can play an important role. Biologists and authoriteis in Hokkaido simply are not able to move directly from the present situation to a fully implementable regulations program like that practiced in Europe, North America, or other areas with a long history of wildlife management.

Given this situation, I suggested that Hokkaido consider a system of zoning (McCullough 1990). Three zones were suggested: first, a zone completely protected from hunting in the most remote landscape to assure ultimate survival of these and other wildlife species; second, a zone with considerably more access where hunting is allowed with the goal of having a sustained yield harvest; and third, a zone adjacent to human activities where hunting is heavy to purposefully reduce populations of bears and deer to low levels to minimize hazards and crop damages.

Producing a plan that is workable on the ground in Hokkaido will be difficult because it will not be easy to establish boundaries that are recognizable, and getting compliance from a hunting public that is not used to being regulated. Still, the problems associated with this approach are far more amenable to solution over the short term than the gathering of sufficient biological data to justify control by regulations over this vast wild landscape. By the time data are available, the brown bear may well be extirpated from many areas.

In Hokkaido, remote country and topography are related; mountaintops are the most remote, valley bottoms most developed for agriculture and other human uses, and intermediate slopes somewhat modified for access associated with forestry. To a considerable extent, the road system controls access and already indirectly enforces to some degree the proposed zoning plan. Clearly the road and trail system needs to be taken into account in placing the boundaries for the three zones.

Sustained yield would come from the second zone where access to the areas is already present. The iterative process of increasing harvest would not work correctly in a zoning scheme based upon mountain tops being protected. The approach depends upon progressively increasing boundary between hunted and protected areas across which dispersal of wildlife would occur. If the boundary between hunted and protected areas was based upon a mountaintop, then increasing the hunting area by moving the boundary to higher elevation would decrease the size of the boundary because each concentrically smaller circle enclosing the mountain top would have a decreasing circumference. Thus, the rationale of the iterative process (i.e., to increase the boundary perimeter to allow greater dispersal from protected to hunted areas) would be contradicted.

Obviously, the iterative process should be based upon subdivisions of the second, the intermediate zone, designated for sustained yield. these divisions might be based on drainages in which stream courses and ridgetops give identifiable boundaries as well as roads and other physiographic (e.g., cliffs), cultural (e.g., power lines), or biological (e.g., vegetation types) landmarks.

The full plan will take some time to implement. Initially the first three zones should be established to achieve the minimal protection to assure survival of the species. It is probably prudent to make the completely protected zone one as large as feasible because some intrusion by hunters along the boundary is likely and the zone can always be reduced later when and if it is clear that it is unnecessarily large. Subdivisions of the intermediate zone to achieve closer control over sustained harvest can follow, and proceed at a rate at which planning and compliance of hunters can be achieved. Finally, control of harvest by regulations can be substituted for the spatial approach when adequate data and controls are obtained to justify the switchover. Perhaps the spatial control system will prove adequate, and harvest by regulation will not be an advantage. Only experience will determine how management will develop. Under the most favorable case, some stage of the spatial control approach will prove adequate to

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Finally, any system will require compliance of hunters, either voluntarily or by adequate law enforcement. No outsider can determine how this compliance should be achieved. Only the Japanese within their political, economic, legal and cultural traditions can determine how best to bring about the necessary compliance if wildlife populations are to be maintained and support sustained harvests.

APPLICATION TO TAIWAN

Wildlife management problems in Taiwan have many similarities to those in Hokkaido (McCullough 1974, Patel et al. 1989). Taiwan has achieved economic development. However, wildlife conservation and management are still in their early stages, despite impressive progress. Extensive forests make population data extremely difficult to obtain; there are few trained biologists relative to the needs for data and the infrastructure to conduct wildlife management is not yet well developed. Subsistence and market hunting (Wang 1989) are difficult to regulate and controls are not part of the cultural tradition of the hunters. Once again the current programs in North America and Europe seem to be unrealistic models until some time in the distant future. Spatial control approaches seem to be the most viable alternative in the meantime.

The existing national park and reserve system, many of which are remote areas centered on high mountains, already constitute a reasonable system of protected zones (McHenry 1984, anonymous, no date). Although some particularly threatened species (e.g., the clouded leopard (*Neofelis nebulosa*), require total protection everywhere, another set of species are more appropriate candidates for sustained yield harvest programs (McCullough 1974).

How can harvest controls on these populations managed for sustained yield be accomplished? My personal experiences in the mountains of Taiwan make me doubt whether adequate data can be generated to support a system based on harvest control by regulation. Given the difficulties, it is a major task to do research on the basis life history and population biology of many of the species.

Because the alternatives seem so unworkable, spatial control systems seem most promising. There is already an intention to prevent hunting in national parks and reserves. What about the areas outside these where hunting occurs? Are there enough areas where lack of access or dangerous steep slopes seve as natural refuges? Can designated protected areas actually be protected by voluntary compliance of hunters or enforcement? If individual hunters or groups of hunters are assigned exclusive access to hunt in certain areas will they adequately patrol and protect their own areas? Can "no man's lands" between exclusive hunting areas serve as protected zones? How big do such areas have to be to protect the important hunted species? Will hunters report kills in ways that sllow a reasonable determination of harvest trends? Is the progressive increase of protected area feasible for attempting to increase harvests?

I do not pretent to know the answers to these questions but they would seem to warrant evaluation. This evaluation could take the form of a workshop of biologists and agency personnel to discuss the feasibility and develop the specifics of such a program. If such an evaluation suggested that the spatial approach had promise, perhaps a given area might be selected to conduct a pilot study in order to test the workability of the approach.

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THE ROLE OF A NATURAL HISTORY MUSEUM IN NATURE CONSERVATION: HOW TO ENHANCE THE INTEREST TO WILDLIFE AND NATURE CONSERVATION THROUGH ITS ACTIVITY

宮武賴夫

Yorio Miyatake

Abstract. For wildlife conservation a natural history museum should carry out many important roles through its various activities, e.g. exhibition or display, education, research and survey, collection of natural history objects and management of collection. Especially educational activities like the field observation programs are very important from the viewpoint of nature education. Every effort is made for participants to enhance their interest to wildlife and nature conservation on such occasions. First, we make attractive plan for field observation as much as possible. Second, it would be better to take them to the interesting places, so that they can meet and observe nature themselves, not necessarily far away but near by. Third, not only watching but touching experiences or coming in contact with plants or insects, etc. are very important. Then, we tell them the system of nature and how closely we are associated with nature. Thus, people are interested in wildlife, and can realize how valuable the surrounding nature is. In the future, we wish all of them understand how human being can coexist and associate with nature.

Usually a natural history museum has four kinds of activities; e.g. exhibition or display, education, research and survey, and collection of natural history objects and management of collection. All of those activities are indeed concerned with the nature conservation as follows:

(1) Exhibition or display

To many people, the function or the role of a museum starts and ends with attractive and stimulating displays often in glass cases and in large exhibit halls or galleries. But, such displays are often big sources of interests to nature or wildlife by the school children, the university students and ordinary people. Our general exhibitions in Osaka Museum of Natural History are arranged in reverse direction, from present to the ancient time, showing the change of nature affected by urbanization, agricultural development, pollution, industrialization, etc. Those processes are shown by the themes such as "Naturalized plants and animals", "Urban nature", "Rural nature", "Nature of country forest", "Virgin forest in Osaka", etc.

In another corner, there are some exhibitions concerned with the conservation of water front, e.g. the river and river bed, the bay area, and the sea shore. In each exhibition, there is shown somewhat more previous and rich phase and subsequent change caused by human works is explained.

Through these exhibitions, we are showing our main theme "Nature and Man" which describes how man used to deal with nature and how man should treat nature in the future.

Occasionally we have the special exhibitions on the local nature to show the results of our survey of the particular region, especially from the viewpoint of nature conservation.

(2) Collection of natural history objects and management of collection

A natural history museum has a fundamental role or function to build up a scientific collection of materials based on natural history researches and to serve as a repository for natural history objects for further research or other purpose From the stand-point of recording every document of wildlife, it should be required to collect everything even rare species or endangered species.

As the private collections accumulated for long time often given an account of the chronological change of the local fauna or flora, those are very important and worth obtaining to a natural history museum. It is recommended to approach timely such collections for getting them as much as possible. In our museum those collections are mostly donated.

In addition to the specimens, the secondary material regarding with natural history, such as books, publications, films, tapes, data, etc. should be collected also domestically and internationally.

As an important documentation center, especially for natural history objects, a natural history museum provides a permanent record of local fauna and flora through its collections. This function is particularly important, because wildlife has been quickly destroyed by human activities recently.

Another function of a natural history museum is acting as the base of sending message based on the accumulated information. Anybody can ask for any information or data. For those services, computer system and network is supposed to be quite useful.

(3) Research and survey

It is most important and urgent to know the exact situation of the local wildlife in the present time by field survey of a natural history museum. It should be the starting point of nature conservation. Researches on the collected specimens and data are also important to figure out how nature changed in the certain area especially caused by human impact. Then, an idea how we can manage to protect or conserve wildlife might come out.

Results of those surveys and researches are important base of activities of a natural history museum and closely associated with other activities.

(4) Education or educational activities

People living in the big cities like Osaka have very few chance to meet nature and to have interest to nature. Therefore, the natural history museum should take them out to the interesting nature as much as possible, so that they can meet and observe nature themselves. It is very important to them that knowledge about nature had better be given in nature and they can think of it in nature. Through these experiences, they are getting the interests to nature gradually. When we seek for the site or nature for observation, it is not necessary to go to far place but nearby place for half day or one day trip will be enough. On the other hand, we should make an attractive plan for the field observation to enhance their interests to wildlife or nature.

In our museum, we have various kinds of educational activities, e.g., outdoor nature study program (junior class - about 5 times a year and senior class - about 12 times a year), natural history hiking (about 4 times a year), nature walk in the botanical garden (monthly), indoor practice (about 5 times a year), lecture class of natural history (monthly), and scientific films (monthly). Among those programs, junior class of outdoor nature study (field observation) and natural history hiking are somewhat for the beginner class to give a stimulus to feel interest to nature to the participants. Others are nearly for the advanced or senior class to strengthen their interests.

For examples, the entomological programs carried lately are as follows: "Olympic game of grasshoppers", "Observation of ants", "Observation of overwintering insects", "Insects come to flowers", "Observation of cicadas", "Searching caterpillars", etc.

During the field observations, we recommend them not only watching but touching or catching, and sometimes collecting plants and insects when the situation permits, except for the bird watching. I believe that this is the best way to know and understand nature really. Sometimes, however, we manage to carry out such a field observation event without giving heavy damage to nature. For example, in "Olympic games of grasshoppers", we tell them to catch as many species as possible at first, then let them sort out all grasshoppers they caught. Finally they enjoy to release all grasshoppers by a flying or jumping match competing jumping distance or flying time of each species or sex. In "Observation on cicadas", we do not use any catching net for collecting adults, but we make observations based on only their sounds and cast-off skins (exuviae), both of which give no effect to nature if collected too much.

For more advanced group, we have a "Museum Association for Nature Study" with more than 1,600 members now. This association has its own educational programs and monthly educational journal "Nature Study", although those activities are supported by the museum as one of the most important educational activities of the museum.

As one of their education program, there has been a two-day tour of "Guide course for insect collecting" since 1988 for boys or girls and their parents, teaching how to observe insects in the fields, how to catch them and how to make the specimens. The purpose of this project is to bring up the so-called "Insect boys or girls" who like insects or insect collecting but has recently much reduced than before, although insect collecting is quite effective for having interest to wildlife, understanding nature and extending to the nature conservation subsequently. In Japan, there is recently a tendency that insect collecting is regarded as a kind of crime or irregular practice, for the reason that it causes the reduction of insects and is against the nature conservation. It is not correct, however, for the reduction of insects is due more to the destruction of habitats or environments but not by collecting, because the fecundity is quite high in insects. Anyway, this project seems to be successful, and some "insect boys and girls" are growing up since then. There appears to have some changes among attending parents also, especially among mothers. They became more accustomed to insects than before.

The most advanced classes are circles or research groups of various fields. Entomological circles or research groups associated with our museum are as follow: "Research group of dragonflies in West Japan", "Research circle of insect migration", "Research circle of moths in Osaka", "Research group of management of entomological information", and several organizations of the nature conservation. The members of these circles are mixture of students, workers and specialists. They are quite helpful for all activities of the museum and can be a leader or teacher in the educational program of nature and nature conservation.

Thus we have a long series of the educational system of nature and nature conservation from the primary school to the graduate course in our museum. Through these activities, people are getting interest to wildlife, and realize how valuable the surrounding nature is. Furthermore, they know the system of nature and think of coexistence and association with nature.

Lastly, we should give precise advice and appropriate comment to the administration or trading occasionally from the viewpoint of nature conservation, especially on occasions of the environmental assessment. Usually the assessment is required before entering into the exploitation. Its purpose should have been pirmarily used to protect wildlife or nature technically, but it is not effective recently. When the administrative authority inspect and judge the results of the assessment, they tend to give permission of exploitation unless the natural monument or the rare species inhabit in the area is concerned. It is a serious problem that the neighboring nature with considerable fauna and flora not including rare species has been thus lost year by year, because those places are quite important and significant especially for the urban residents to meet and observe nature easily.

On the other hand, it seems to be another problem that certain rare species or endangered species is simply designated as a ntural monument or specially protected species and prohibited to catch and collect in Japan. As this kind of regulation is usually not accompanied with protection of its habitat, it can not be protected if the habitat is seriously damaged. And, such designation gives economical value to that species, resulting from collecting.

Anyway, for the innovation of nature a natural-history museum should keep watch on and speak timely.

Further, effective educational activities of the museum can be done by the publication of guidebooks or textbooks, lectures, symposia, nature study tour and propagation through mass communication. For the survey or conservation of local fauna and flora, it will be satisfactory to get cooperation from local students, workers, specialists and others who are interested in nature.

Next, I show you the recent successful instance of the dragonfly conservation with the cooperation of citizen, local people and nation wide by finance and labor.

(5) Example of the conservation of dragonflies in Japan

The first sanctuary for dragonflies has been constructed in Nakamura City of Kochi Prefecture in Southwestern Japan since 1985. It is so-called "Kingdom of Dragonflies" and is partly sponsored by the World Wide Fund for Nature Japan.

As Nakamura city is located on the Shimanto Basin, the dragonfly fauna of this area used to be quite rich, but it became poorer by exploitation. This project was started by one young man, Mr. Sugimura, but soon supported by many citizen or others from all over Japan. Then, they made the association of conservation of nature and dragonflies, and obtained the rested paddyfields for the sanctuary. For making the site better for dragonflies, they dug down the area or made new ponds somewhere, and planted considerable aquatic vegetation. These operations were supported by many members, citizen, organizations and specialists as volunteers. Now 67 species of dragonflies which cover nearly one third of the Japanese dragonfly fauna can be observed inside the protected area of three hectares. Their association with over 1,100 members now is planning to enlarge it to fifty hectares with more than 70 species of dragonflies. In the spring of 1990, the Municipal Dragonfly Museum opened in the nature park of dragonflies and it should be the active headquarters for the conservation of dragonflies and nature through its various activities.

The good points of this project is that everybody is easily interested in dragonflies and dragonfly is the good entrance to understand nature and consider of nature conservation. Another good is that many people can join and enjoy to attend the project, since it is the long-range project and needs various assistance. The good combination of sanctuary, museum and association must be the successful point of this project also.

On the contrary, the problem of this project is that the conservation is based upon the reconstruction and management of nature, and too much concentrated to the special and selected group of insects. In the future, after a considerable success of the dragonfly sanctuary, this museum should act as a natural history museum with wider viewpoint of nature for the protection of whole wildlife of the area concerned.

In conclusion I should like to say that a natural history museum should be a teacher or consultant for any case, any level, any people or any organization, both in principles and in practices in carrying out the nature conservation, based upon its own researches and surveys, and the accumulated information from various sources. On the other hand, a natural history museum should try hard to enhance the interest to nature and nature conservation for as many people as possible in every occasion, and should be a center of the network associated with citizen, associations, and administration in promoting the nature conservation. And the final object should be to find out how human being can coexist and associate with nature.

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CONSERVATION OF FRESHWATER FISHES WITH EMPHASIS ON ITS RELATION TO PHYSICAL ENVIRONMENT AND ECOLOGICAL DIVERSITY

川那部浩哉

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Abstract. In 1989, Environmental Agency of Japanese Government made a red data book of animals, in which it was recognized that 2 subspecies has been already extinct, 16 species or subspecies are now inclining to extinct, and 6 species or subspecies are extremely dangerous in freshwater fishes.

Cause of such extinct or dangerous situation was mostly chemical environments in earlier days. At present, however, change of physical environments is extremely serious issue in both lakes and rivers, with complex of other environmental problem.

Distribution and mode of life of Ayu, Plecoglossus altivelis, the most important fish from fishery point of view, will be presented with changes of physical environment or river morphology at first. Effect of imported fish on native ones will be discussed with change of physical and chemical environments. Test study of river reconstruction for better living of fishes will be shown, too.

Importance of conservation of local populations and of genetical diversity in a particular body of water will be also emphasized.

CONSERVATION OF FRESHWATER FISHES IN JAPANESE ARCHIPELAGO WITH EMPHASIS ON ITS RELATION TO ITS PHYSICAL ENVIRONMENT AND LOWER LEVEL DIVERSITY*

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INTRODUCTION

In 1989, the Environmental Agency made the Red Data book of animals in Japan. It was recognized that 2 endemic subspecies of freshwater fishes have been extinct, 16 species, subspecies or forms of them are endangered to extinct, another 6 species, subspecies or form are critical or emergent stiuation of extinction, and other 17 species, subspecies are now rare (Table 1). It is extremely serious situation in comparison with that the total number of freshwater and diadromous fish species or subspecies are about 200 in all over the Japanese Archipelago (e.g., Miyadi et al., 1976).

Salmo (*Oncorhynchus nerka kawamurai*) lived only in Lake Tazawa in Tohoku District, transparency of which had the highest value in lakes all over the world. The fish seemed to have extraordinally long spawning season: old fishermen believed it spawned throughout years. In late 1930s, an electric power company wished to use the lake as a reservoir and extremely acidic water, pH 1.8, was introduced from River Tama to the lake. After that date, unfortunately but naturally, all organisms have been extinct in the lake (Miyadi et al., 1976; Oshima, 1941).

* Contribution from the Laboratory of Animal Ecology, Department of Zoology, Kyoto University, No. xxx, and from the Centre for Ecological Research, Kyoto University

Pungitius pungitius kaibarae was distributed sporadically in Kinki District, especially in southern part of Kyoto city. Its main habitat was Japanese-parsley-ponds into which clear water came from springs nearby. Since 1920s some of them were cultivated to be rice-field, most of them got sewege, manure or fertilizer and water quality of these ponds became eutrophic. So, we have not been able to find any individuals of this subspecies since the later half of 1950s (Kobayashi, 1933; Miyadi et al., 1976; Tan, 1928).

In earlier days, conservation problem of freshwater fishes in Japanese Archipelago was mainly based on chemical pollution, both inorganic and organic, as such as mentioned above. The extinction of Auy, Xiang-yu, *Plecoglossus altivelis* subsp. in Tamsui River, Taiwan Island was also caused with anaerobic condition of water by getting sewege from Taipei city and its environs (Kawanabe, 1971).

IMPORTANCE OF PHYSICAL ENVIRONMENTAL CHANGE UPON FISHES

Water pollution problems are now well known by general public and some environmental laws have been established about it in Japanese Archipelago. So, the next and the most serious situation for freshwater fishes at present is change of physical environment or some other factors with change of physical environment.

Riffles and pools: components of stream and river

Type of streams and rivers has been defined by many authors in different ways. From ecological point of view, Kani's classification (Kani, 1944, 1981) is the most important and useful one. He recognized that a unit of river is a meandering course whcih consists of riffle(s) and pool(s).

In upper reaches of river, a meandering course has many riffles and pools (type A), whereas a meander has a riffle and a pool in middle and lower reaches of river (type B). He also noticed that water surface from a riffle to a pool is different in relation to different reaches of river: i.e., falling down from a riffle into a pool in the upper reach (typa a), flowing down with some turbulence of water surface in the middle reach (type b), and flowing withoug turbulance in the lower reach (type c). the type A is corresponds to the type a and the type B is to the type b or c.

Streams and rivers always meander. A pool is there at every meandering point. In the middle reach as the typical example, the exterior side of the pool is deep with steep rock, whereas the interior side is shallow with gentle slope and consists of sand and stones. A pool gradually becomes shallower with sand bottom, a smooth-riffle comes next, and it continues to a coarse-riffle. The last one flows down to the next pool with surface turbulance.

"Environment" of environment

In Japanese Archipelago, ecologically and commercially the most dominant and important freshwater fish is Ayu. This species feeds on microalgae and cyanobacteria attaching on stones and rocks. So its main habitat is riffles and the external part of river-pools in the middle reach of rivers. There are also hiding and sleeping places for the fish in coarse-riffles where big rocks and stones pile up with each other, so that population density of the fish is the highest in the coarse-riffle. Pools have excellent hiding place but few place for feeding, so that population density is medium in the pool. Smooth-riffles having only stones in one layer have no hiding places, so that the population density is low, nevertheless food amount is rather similar to that in the coarse-riffles (e.g., Kawanabe, 1958, 1970).

If a smooth-riffle is situated closely to a good pool, however, we can find many individuals of Ayu going to the riffle for feeding on algae and back to the pool for hiding or sleeping. So, the population density is much higher in the both river-beds than that in separate riffle and pool (Kawanabe et al, 1957). It would be emphasized, therefore, that not only value of each habitat itself but also connexion of these habitats is extremely important for Ayu.

Many salmonid fishes are insect feeders. They feed mainly or exclusively on drifting ones in water-column appeared from terrestrial or benthic orgin, however. An amount of drifting insects is the highest in surface layer of main course of water current, so that feeding point should be situated in this part (Furukawa-Tanaka, 1985, unpublished). If the fish located there all the time, however, cost of energy consumed would be extremely high, because it had to swim against high speed of the water current. It was recently found clearly in white-spotted charr, *Salvelinus leucomaenis pluvius*, that each individual waits in slower part of the current, and when find foods, it dashes up to the surface layer for catching the foods (Furukawa-Tanaka, unpublished). It is extremely convenient or necessary condition, therefore, for the charr that place with high speed current and place with low speed current are located nearby with each other.

Usual construction for so-called flood control or river improvement makes rivers as ditches, and most of coarse-riffles and pools are destroyed and only smooth-riffles are remained with small dams. Meandering disappear, too. Allmost all banksare paved by concrete. In these situation Ayu is not able to survive. Charr cannot also find its good habitat in such kind of ditch. *Acheilognathus longipinnis, Rhodeus sinensis suigensis* (Nagata in Kawanabe & Mizuno, 1989), *Leptobotia curta* (Katano in Kawanabe & Mizuno, 1989) and *Pseudobagrus (Coreobagrus) ichikawai* (Mori & Nagoshi in Kawanabe and Mizuno, 1989), for example, are almost extinct now for this kind of change, too.

Deforestation and its related subjects also change physical environment of river. Mode of these changes are similar to ones made by the usual construction: no coarse-riffles and pools but only smooth-riffles. *Plecoglossus altivelis ryukyuensis* is inclining to extinct by both deforestation and river construction (Niimura, 1989).

Continuity of flowing water

For diadromous fishes such as Ayu and many other salmonids, eels and gobies, it is well understood that river should be connected to the sea; dam, if present, should be completely free for fishes to go across upward and downward.

Also for purely freshwater fishes, however, they cannot survive without moving up and down in rivers. Pale chub, *zacco platypus*, lays its eggs from lower part of the upper reach to middle part of the middle reach. when its fry grows up about 2 cm, their home range size expands largely. At this stage, they still need to lower speed current, so that there are no broad places for them around their nursury area. They descend to lower part of the middle reach as well as the lower reach, where slow-flowing part are present in broad area. They ascend the river several months later, when they would have more swimming ability (Mizuno & Nagoshi, 1964, Mizuno et al, 1958, Nagoshi et al, 1962). Similar situation is also recognized typically on river-resident types of *Salvelinus leucomaenis* subspp. and *Salmo (Oncorhynchus) masou* subspp.

Such kind of movement is also shown in other organisms. For example, adults of the net-spinning caddis, *Stenopsyche japonica*, fly up in air for spawning. Females of the caddis goes upwards about 15-30 cm above the river surface with the help of the reflexion of water. If reflexion can not be seen at particular site of the river, for stones or rocks pile up with each other and water surface was hidden, they cannot find continuity of water and stop to fly up there. In upper part of the river than that point, as the result, there are no distribution of this species at all in the next generation and the follows (Nishimura, 1959, 1967, 1976, 1981).

Ascending and descending rivers is natural and essential condition for most organisms living in the rivers. Extremely careful construction is needed for conservation of river fishes and other organisms.

Salanx ariakensis and *Salangichtys (Neosalanx) regani*, endemic species of Ariake Bay, are now endengered mainly by the construction of chikugo Dam at the mouth of the River Chikugo (Taklita in Kawanabe & Mizuno, 1989)

Effect of exotic fishes on native fishes in relation to environmental change

Very clear phenomenon was observed in introducting of pale chub to rivers of Shikoku Island in relation to change of river morphology (Miyadi et al, 1960). There had been dominated with dark chub, *Z. temmincki*, in those rivers originally, and pale chub was introduced with Ayu from Lake Biwa in almost every year since 1933. Before the World War II, distribution of introduced pale chub was extremely restricted only in several rivers, slope of which was gentle. From 1950s the river construction was done in many rivers, and a tremendous number of pale chub was observed and a number of dark chub was extremely decreased in each river 4 or 5 year after the construction made.

Similar situation was occurred for gudgeon, *Pseudogobio esocinus esocinus* in River Ukawa after heavy sedimentation of sand on its river-bed caused by carelees road construction (Kawanabe, unpublished)

In the southern basin of Lake biwa at present, only 1 species of bitterling, largemouth blackbass, *Micropterus salmoides*, and bluegill, *Lepomis macrochirus*, the latter two of which are exotic species from the United States, can be caught (Maehata, 1987). During early 1970s, however, distribution of bluegill was restricted along the shore without reeds, and many native species were distributed with the fish. Also in this case, therefore, I should stress the change of physical and chemical environment of the lake. Since late 1970s, water pollution has become serious and reed marsh was heavily damaged and almost all shorelines have been covered or paved by concrete blocks. And then, the present situation was observed.

Similar situation is occurred with *Sarotherodon mossambicus* in the Ryukyus.

Introducing of exotic species should not be done, of course. I would like to stress, however, fish community or society in Asian Continent and its related islands is not so extremely weak against such exotic species as remote islands like New Zealand. But, if physical and chemical environment changes, it has been clear that the community become extremely vulbarable for invasion of exotic species.

IMPORTANCE OF LOWER LEVEL DIVERSITY

Conservation of local populations

Freshwater fishes are the most conservative organisms in biogeographical sense. Most birds can migrate from a continent to others or to even remote islands rather easily. When Taiwan Strait, for instance, was dried up, mammalian species could go across the strait. Even in organisms living in lakes and rivers, aquatic insects can fly, molluscs can grasp at leg of birds and move somewhere. Freshwater fishes, especially primary ones, however, cannot go across mountains nor go to other rivers through the sea. Only during the case of connexion being present between river systems, they could move from one to the other. For example, the rivers flowing down into east part of Seto Inland Sea joined together at Kii Strait and then flew into the Pacific Ocean, whereas the rivers down into west part of the inland sea joined together at Iyo Strait and into the ocean, during the last glacial age. That means, conspecific fish living in the former or the latter rivers have separated with each other about 10,000 years up to now, and fish living in the former and the latter area since much more than 10,000 year ago, probably more than 100,000.

As far as I know, good speciation of fishes was occurred during recent 4,000 years at shortest in cichlids between Lakes victoria and Nabugabo (Greenwood, 1965). So, 10,000 years would be enough time for speciation in some species of fish. We should imagine, therefore, that most conspecific populations of freshwater fish living in separate water systems would have clearly different genetic patterns with each other.

Ecological differences are observed between local populations in many freshwater fishes, e.g., Ayu-like loach, *Leptobotia curta*, landlocked form of three-spined stickleback, *Gasterosteus aculeatus leiurus* (Mori, 1987), and even in diadromous fish such as pond smelt, *Hypomessus transpacificus nipponensis*.

I would like to stress that each local population of freshwater fish has own genetical and ecological feature, so that we have to conserve every species in every water system at least.

Conservation of genetical diversity in a population

Even in a local population are there large genetic diversity, on which ecological diversity is partly depended. Unfortunately, however, little attention have been made this issue scientifically up to now.

In Taiwan Island, there is an endemic Formosan salmon, Salmo *(Oncorhynchus) masou formosanus*. There are three other subspecies in this masou complex in the world (e.g., Kawanabe, 1989): *S. (O.) masou masou, S. (O.) masou* subsp., and *S. (O.) masou ishikawai*, in Kimura's sense (Kimura, 1990). *S. (O.) masou masou* is distributed rather widely in coller part of the Far East and has both sea-run and river-resident types. *S. (O.) masou* subsp. is an endemic species in Lake Biwa, and has only lake-run type. *S. (O.) masou ishikawai* is distributed in central-southern part of Japanese Archipelago, and almost all individuals show river-resident behaviour. A few individuals showing sea-run behaviour was found in many estuarine area until 1940s, but a good population of this type remains, unfortunately, only in River Nagara, flowing through Gifu City into Ise Bay, Pacific Ocean side, at present. In this river, now dam construction is progressing at the river mouth by Japanese Government.

From preliminary survey on electropholetic analysis, there seems to be some genetic differences between the sea-run and river-resident types of this subspecies. If the sea-run type will be extinct by the dam construction, we will lost this type from all over the world.

Recently, intensive genetic analysis was done in Ayu. Differences between its sea-run and lake-run populations were already known, but among the sea-run forms and among individuals in a population some difference were newly detected. Moreover, it was also found that genetic diversity of aquacultured populations was extremely narrower than that of natural ones (Numachi, unpublished). It could be logically forecasted, but it was now confirmed.

Frankly saying, some fishery scientists have thought that the stocking of fish can serve its population. Unfortunately, however, the stocking to natural population would not keep but decrease greatly the genetic diversity of the population. We have to conserve genetic diversity in every population of every species, I would like to stress.

CONCLUSION

Freshwater fishes are "generalists" in ecological sense. Food and reproductive habits are usually rather broad in comparison with not only marine fishes but also terrestrial vertebrates as well as invertebrates. Unfortunately, however, its broadness is not enough tolerant to serious environmental change at present caused by human activity. To change of characters to become different species, it need more than several thousands years at shortest, as was mentioned earlier.

Habitat problem is very important for all organisms. Especially in river fishes and shore fishes in lakes physical environment is extremely important for their food-taking, reproduction and hiding from their enemies. Competitive relation is also occurred in relation to its habitat. So, particularly in the present situation, we need to emphasize conservation of physical environment, I dare say its morphology, for freshwater organisms.

I would like to also stress that genetic and ecological diversities are extremely important especially for freshwater fishes having generalistic behaviours.

In this viewpoint of mine, I incline to admire the recent conservation project of Formosan salmon, Ying-Hua-Ju-Wen-Gui, by Taiwan Government and researchers directed by Chang and Lin (Lin & Chang, 1989; Lin et al, 1990, 1991). It is slightly too late, I am afraid, so that the situation is extremely serious and there is no knowing what will happen in future. To make meandering of river, to construct semi-natural river-bank, to remove useless dams, and to conserve genetic diversity, however, is one of the really pioneer works in the world.

I desired that not only genetic diversity but also diversity but also diversity of interspecific relations are shown here, but page is over. So, I would like to end my paper with an old tale in Japanese Archipelago.

In Hokkaido Island, are there Ainu tribe, as the mountain brethren in Taiwan Island. In a folk tale of Ainu people, I found the following one. "In autumn, many chum salmon, *S. (O.) keta*, ascend rivers for spawning. One day, an Ainu catches all individuals of the salmon for his family. At that night a fox crys around the village that 'Salmon is not only for Ainu but also for foxes, bears, and other animals. Today, a bad Ainu caught all of them. No remaining individuals of the salmon are there for animals except that ainu. It is unfair. He should return some catches to other animals'. The Ainu village let him return a half of the salmon caught in the river, and those salmons come back to life by Gods' sake" (Kayano, 1977).

Acknowledgements

I would like to acknowledge to Professors K. H. Chang and Y. S. Lin for giving me the opportunity to read this paper on the International Symposium on Wildlife Conservation held at the Academia Sinica at Taipei in 1991.

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Table 1. Red data book of Japanese freshwater fishes (Environmental Agency of Japan, 1989)

Extinct Subspecies (2):

Salmo (Oncorhynchus) nerka kawamurai "kunimasu"
Pungitius pungitius kaibarae "minamitomiyo"

Endangered Species, Subspecies and Forms (16):

Salvelinus leucomaenis f. "kirikuchi"
Salmo (Oncorhynchus) masou ishikawai (sea-run type) "satsukimasu"
S. (O.) masou ishikawai (parrless type) "iwame"
Plecoglossus altivelis ryukyuensis "ryukyuayu"
Salanx ariakensis "ariakeshirauo"
Salangichthys (Neosalanx) regani "ariakehimeshirauo"
Aphyocypris (Aphyocypris) sinensis "hinamoroko"
Pseudorasbora pumila subsp. "ushimotsugo"
Acheilognathus longipinnis "itasenpara"
Rhodeus oceluatus smithi "nihonbaratanago"
R. sinensis suigensis "suigenzenitanago"
Tanakia tanago "miyakotanago"
Leptobotia curta "ayumodoki"
Pseudobagrus (Coreobagrus) ichikawai "nekogigi"
P. (Pseudobagrus) aurantiacus subsp. "ariakegibachi"
Pungitius pungitius subsp. "musashitomiyo"

Emergent species, Subspecies and Forms (6):

Hucho perryi "ito"
Salvelinus leucomaenis f. *imbrius* "gogi"
Leuciscus (Tribolodon) sp. "ukekuchiugui"
Gasterosteus aculeatus leiurus "hariyo"
Boleophthalmus pectinirostris "mutsugoro"
Trachidermus fasciatus "yamanokami"

Rare species and Subspecies (17):

Lampetra (Entosphenus) tridentata "mitsubayatsume"
L. (Lethenteron) kessleri "shiberiayatsume"
Coilia nasus nasus "etsu"

Table 1. (Continued)

Salvelinus malma malma "oshorokoma"
S. malma miyabei "miyabeiwana"
Salmo (Oncorhynchus) masou subsp. "biwamasu"
Pseudorasbora pumila pumila "shinaimotsugo"
Acheilognathus typus "zenitanago"
Pungitius tymensis "ezotomiyo"
Macropodus opercularis "taiwankingyo"
Siniperca (Bryttosus) kawamebari "oyanirami"
Lates japonicus "akame"
Ophieleotris sp. "tanagomodoki"
Chaenogobius taranetzi "shinjikohaze"
Luciogobius pallidus "idomimizuhaze"
L. albus "dokutsumimizuhaze"
Rhyacichthys aspro "tsubasahaze"

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SYSTEMATICS AND BIOGEOGRAPHY OF TERRESTRIAL REPTILES OF TAIWAN

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Abstract. Systematics of Taiwanese reptiles has recently been remarkably progressed, involving descriptions of new taxa, resurrections of previously invalidated names, and additions of new locality records. However, these, as well as recent taxonomic rearrangements of various categories of related taxa, have made it difficult to catch up with nomenclature of Taiwanese reptiles in an up-to-date manner. Such confusion also makes it difficult to evaluate the herpetogeographical properties of Taiwan appropriately. This review is aimed first to provide a contemporary standard of classifications of reptilian taxa recognized from Taiwan, and then to make a preliminary biogeographical analysis on them by assembling the latest knowledges on their distributions and relationships with other taxa from outside.

A total of 75 squamata and 5 testudine species and subspecies are recognized. Analysis using a similarity index demonstrates a closer relationship of the Taiwanese herpetofauna with that of the continent than of the Ryukyu Archipelago or the Philippines. Also, analysis of distributional patterns of the possible closest relatives of endemic taxa strongly suggests the closest historical relationships of Taiwan and the continent. These results well coincide with the geohistorical scenario of Taiwan outlined by geological and geomorphological evidences.

INTRODUCTION

Taiwan is located in the insular region of East Asia, and about 80 km off-shore of the continetal China. The latitudinal location of Taiwan makes its climate primarily subtropical. But the highly complicated geomorphology, resulting from the tectonic movements of the Philippine Plate during Pliocene and Pleistocene (Yen, 1977), has remarkably increased the environmental diversity of the main-island (Kano, 1940), which has supported highly diversified fauna and flora including various reptiles.

Wang and Wang (1956) listed 94, including 82 terrestrial, species and subspecies of reptiles as occurring in Taiwan. The paper is actually an excellent review on knowledges accumulated to that date. However, a large number of systematic works have subsequently been made on the Taiwanese reptiles, involving several additions to and deletions from Wang and Wang's (1956) faunal list, as well as extensive rearrangements of the status of many species and subspecies included there. These have been causing some confusions in the recognition and nomenclature of many of the Taiwanese taxa [see Ota (1991a, b) for example].

As such, it is worth to provide a contemporary standard of classifications of reptilian taxa recognized from Taiwan as below. I also make preliminary biogeographical analyses on them by assembling the latest knowledges on their distributions and relationships with other taxa from outside of Taiwan.

SYSTEMATICS

The following list primarily derives from that provided by Wang and Wang (1956), and therefore, detailed information for each taxon given in that paper is omitted. Distributions of related species and subspecies outside Taiwan are outlined on the basis of information provided by Brown and Alcala (1970, 1978,1980: for the Philippine reptiles), Iverson (1986: for Testudines), Tian and Jiang (1986: for reptiles from the continental China), Toyama (1985: for reptiles from the Ryukyu Archipelago), and Welch (1988: for snakes), unless otherwise noted.

Family Agamidae Gray, 1827

Genus *Japalura* Gray, 1853

Distribution.--Distribution of the genus can be divided into two discontinuous regions: one consists of northern India, Nepal, northern Indochina and the southern China, and the other ranges around the insular East Asia including Taiwan (the main-island, and Lanyu and Lutao Islands) and the Ryukyu Archipelago (Fig. 1). Although two Bornean species had long been assigned also to *Japalura* (Wermuth, 1967), Moody (1980) negated their monophyly with the other species of this genus.

Remarks.-- Classification of Taiwanese *Japalura* has been a history of confusion [see Ota (1991a, c) for review]. Four species and subspecies, all endemic to Taiwan, are currently recognized.

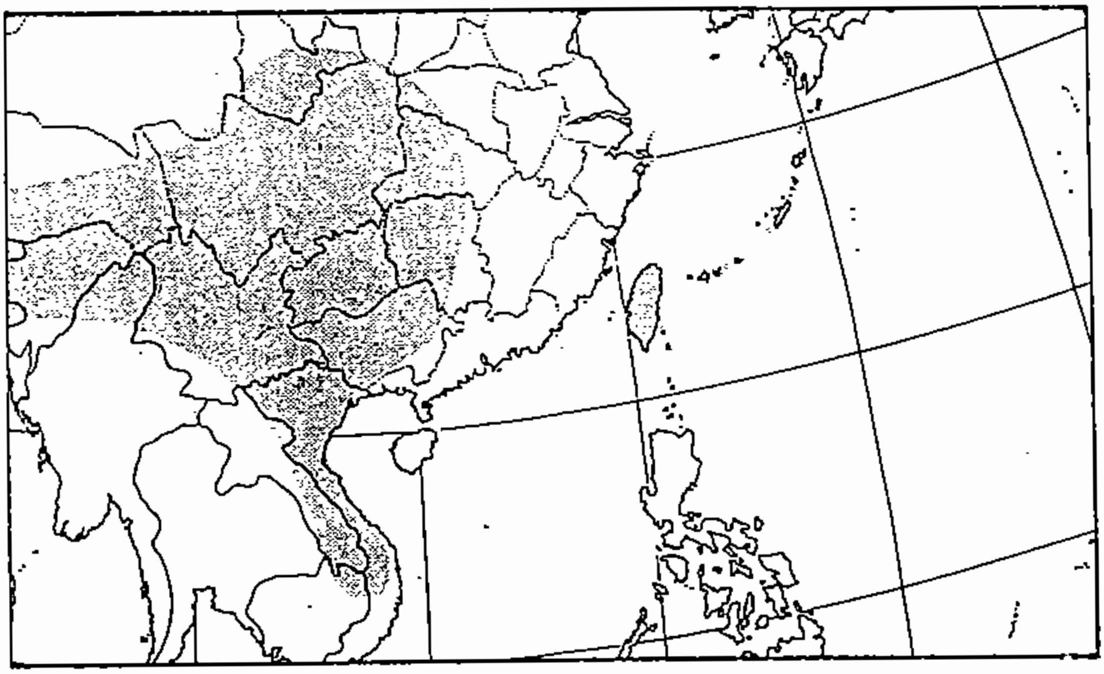


Fig. 1. A map of East and southeast Asia showing the range of the genus *Japalura* (stippled area).

Japalura swinhonis Günther, 1864

<u>Distribution</u>.--Almost all around Taiwan (including Lanyu and Lutao Islands) exclusive of montane and high altitude areas (< c.a. 1200m above sea level: Fig. 2)

<u>Remarks</u>.--The name has long been applied to another form by mistake (Ota, 1991c: see below).

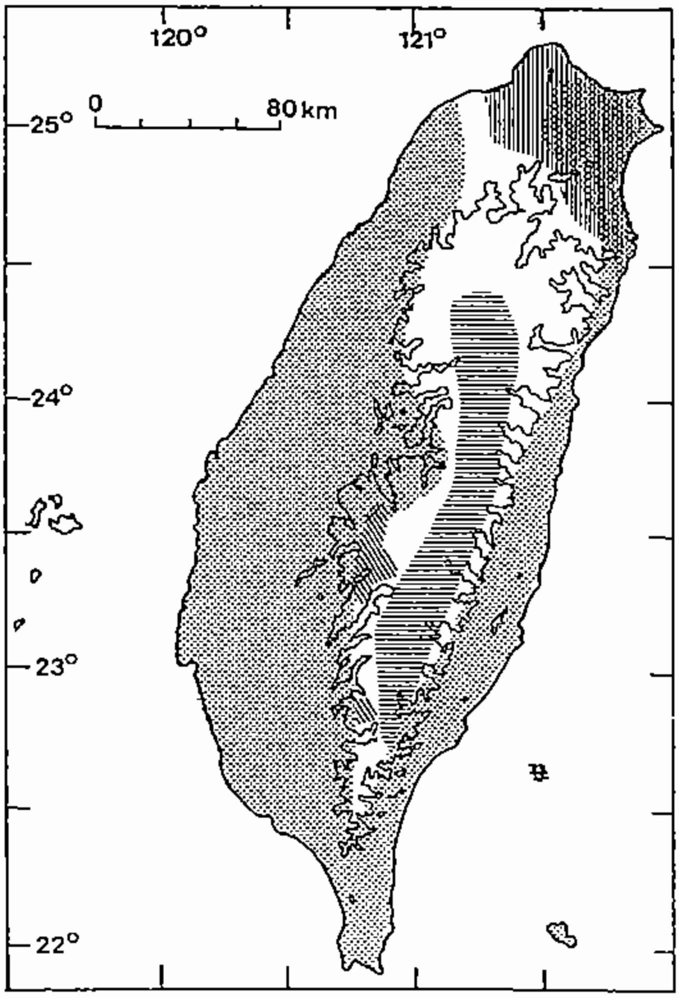
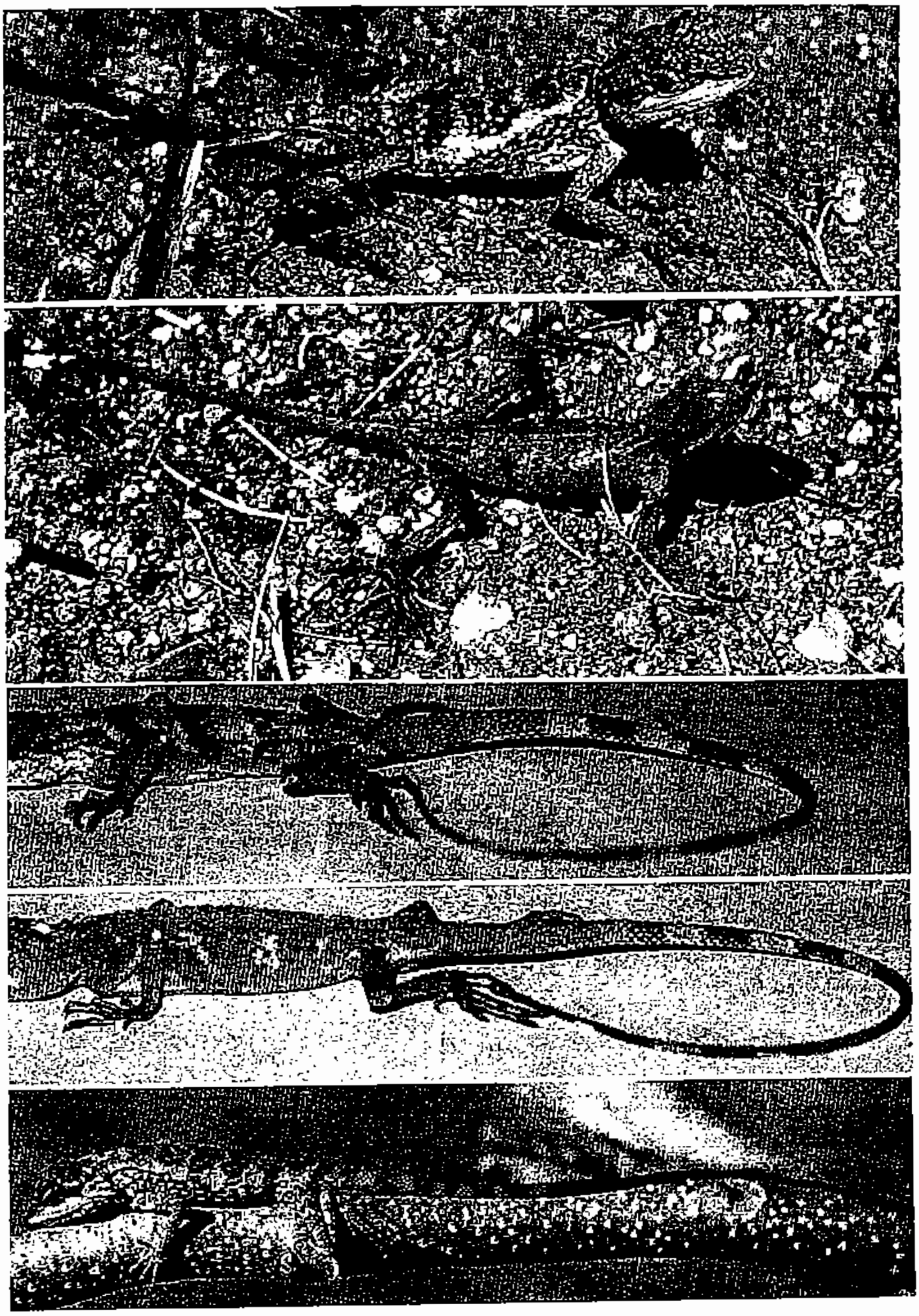


Fig. 2. A map of Taiwan showing ranges of *Japalura swinhonis* (stippled area), *J. brevipes* (horizontally hatched area), *J. makii* (obliquely hatched area), and *J. polygonata* subsp. (vertically hatched area). Contour lines indicate the altitude of 1000 m above sea level.



Photographs of recently dicovered or taxonomically poorly known agamids from Taiwan. A. & B: a male & a female *Japalura brevipes*, respectively. C & D: a male & a female *J. makii*, respectively. E: a female *J. polygonata* subsp.

Japalura brevipes Gressitt, 1936: Fig. 3A & B

Distribution.--Known from central high altitude area of the main-island (> c.a. 1200m above sea level: Fig. 2).

Remarks.--The species had long been regarded as conspecific with *J. swinhonis*, but recently re-evaluated to be a distinct species on the basis of morphological and karyological evidences (Ota, 1989a).

Japalura makii Ota, 1989: Fig. 3C & D

Distribution.--The known distribution of this species is confined to the southwestern flank of the central range of mountains on the main-island (Fig. 2)

Remarks.--The species had long been regarded as conspecific with *J. swinhonis*, but was recently described as a distinct species on the basis of morphological and karyological evidences (Ota, 1989b).

Japalura polygonata subsp.: Fig. 3E

Distribution.--Northern lowland area of the main-island (Fig. 2).

Remarks.--This form had long been regarded as the typical *J swinhonis* by mistake, and were recently proved to be conspecific with *J. polygonata* from the Ryukyu Archipelago (Ota, 1991c).

Family Gekkonidae Gray, 1825

Genus *Gekko* Laurent, 1768

Distribution.--South, Southeast and East Asia, and the western Oceania.

Gekko hokouensis Pope, 1928

Distribution.--The main-island and Lanyu Island (Ota et al., 1988, 1989a). Known also from the Ryukyu Archipelago, southern tip of Kyushu, Japan, and the eastern continental China (Fig. 4).

Remarks.--*Gekko hokouensis* had long been regarded as a junior synonym of *G. japonicus*, but was recently resurrected by Zhou et al. (1982). Taiwanese population was subsequently reassigned to *hokouensis* by Ota et al. (1988, 1989a).

Gekko kikuchii Oshima, 1912: Fig. 5A

Distribution.--Endemic to Lanyu Island (Fig. 4).

Remarks.--Wang (1962) and Lin and Cheng (1990) assumed the close morphological resemblance of this species with *G. monarchus* and *G mindorensis* from Southeast Asia. Ota (1989c) and Ota et al. (1990) provided chromosomal data that support this assumption.

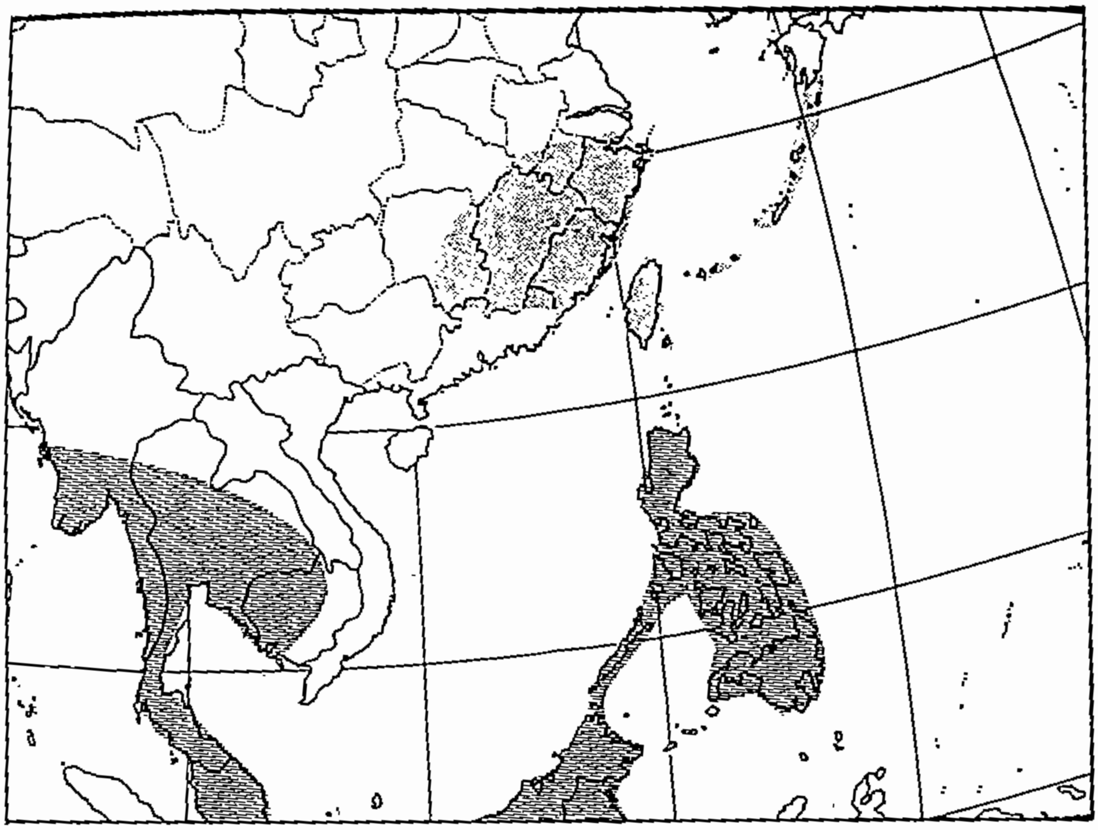


Fig. 4. A map of East and Southeast Asia showing ranges of *Gekko hokouensis* (stippled area) and *G. kikuchii* (vertically hatched area). Ranges of *G. monarchus* and *G. mindorensis*, the possible closet relatives of the latter, are also indicated with horizontal hatches.

Genus *Gehyra* Gray, 1834

Distribution--Australia and areas represented by the range of *G. mutilata* (see below).

Remarks.--Highly diversified in Australia, Oceania, and Indochina (e.g., King, 1983; King and Horner, 1989; Wermuth, 1965).

Gehyra mutilata (Wiegmann, 1835)

Distribution.--The main-island. Widely known from Southeast Asia, islands of Indian and Pacific Oceans, Madagascar and Mexico (Wermuth, 1965: Fig. 6).

Remarks.--This species is very rare in Taiwan (Lue et al., 1987a).

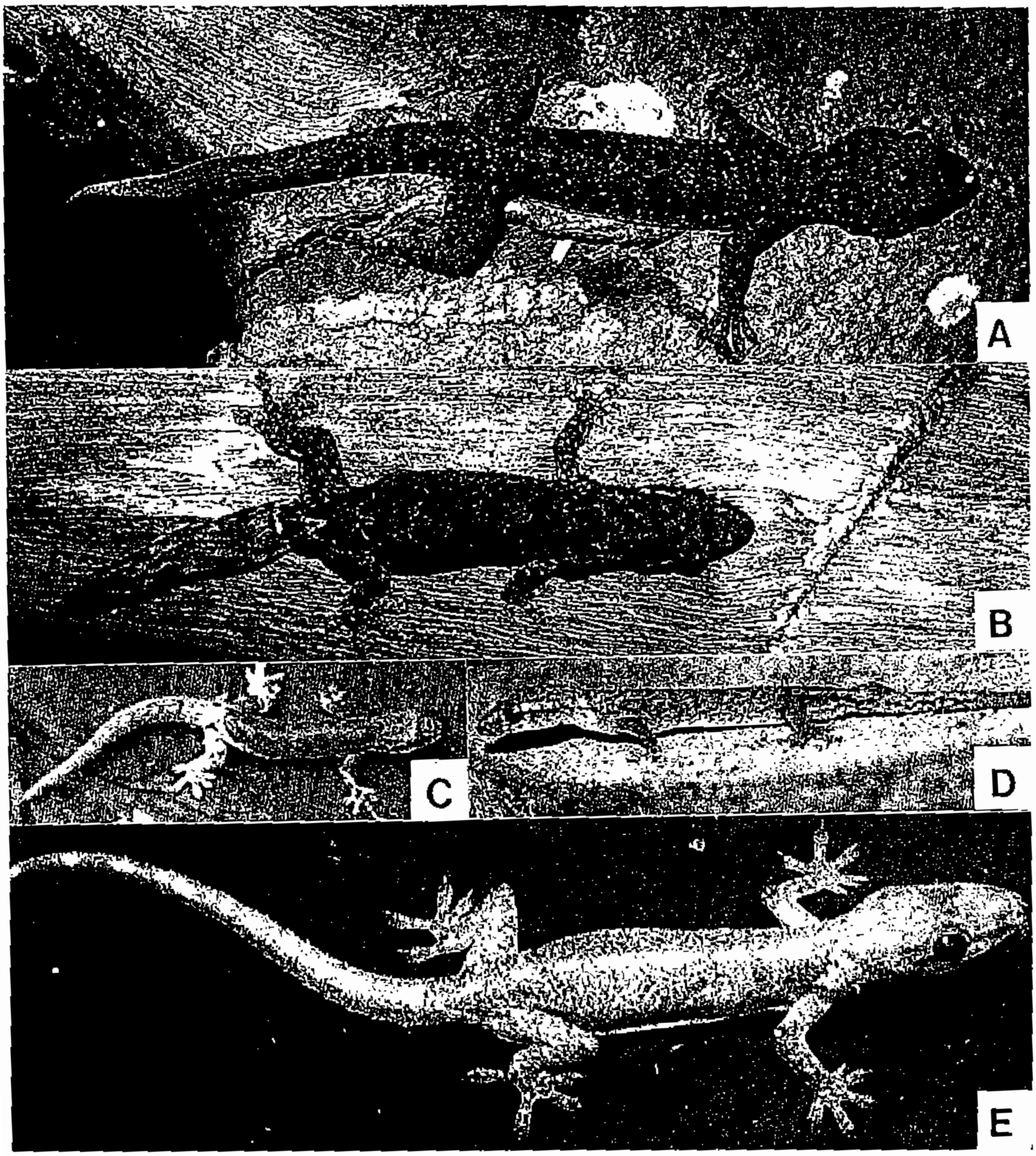


Fig. 5. Photographs of recently discovered or taxonomically poorly known gekkonids from Taiwan. A: *Gekko kikuchii*. B: *Lepidodactylus lugubris*. C: *L. yami*. D: *Hemiphyllodactylus typus typus*. E: *Hemidactylus stejnegeri*.

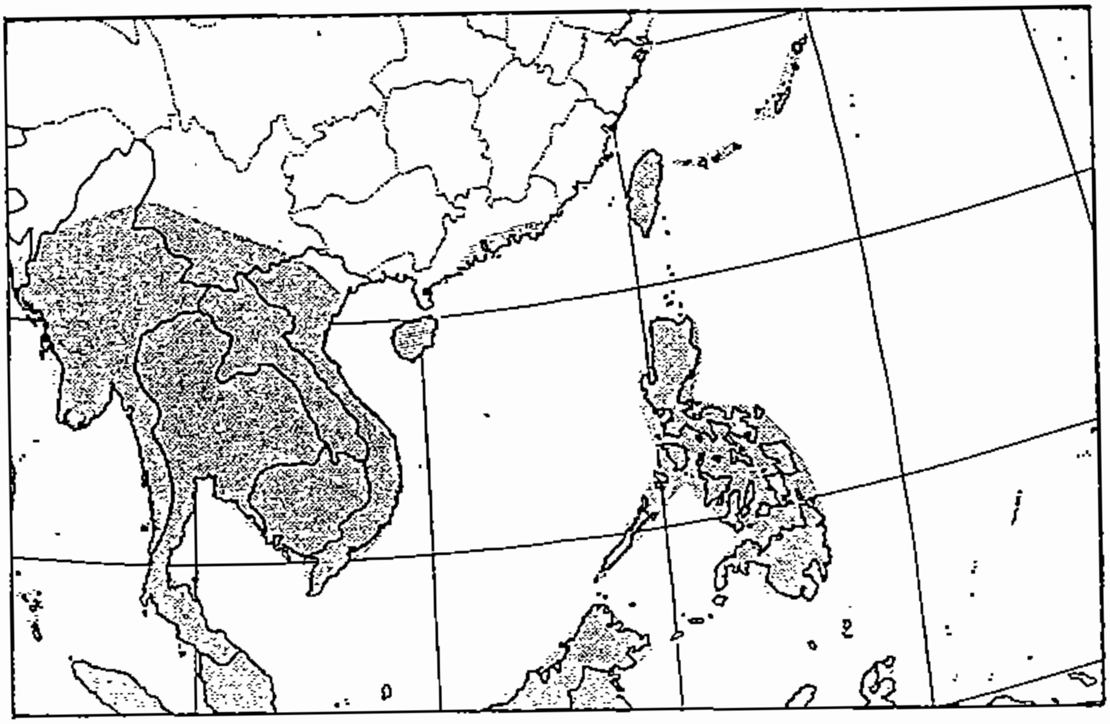


Fig. 6. A map of East and Southeast Asia showing the range of *Gehyra mutilata* (stippled area).

Genus *Lepidodactylus* Fitzinger, 1843

Distribution.--Represented by the range of *L. lugubris* (see below).

Remarks.--Brown and Parker (1977) recognized three subgroups within the genus based on morphological features.

Lepidodactylus lugubris (Duméril et Bibron, 1836): Fig. 5B

Distribution.--The main-island and Lutao Island (Cheng, 1987a; Ota, 1986). Widely distributed in the Ryukyu Archipelago, South and Southeast Asia, Pacific Islands and Central and South America (Ota, 1989c; Peters and Donoso-Barros, 1970; Wermuth, 1965: Fig. 7)

Remarks.--*L. lugubris* is known to be parthenogenetic in general, making itself a successful colonizer, although bisexual populations are also reported (Cuellar and Kluge, 1972; Ineich, 1988; Ota, 1989d). It belongs to Group III of Brown and Parker (1977) characterized by divided terminal scansors on digits and diversified in the Philippines (Brown and Alcala, 1978).

Lepidodactylus yami Ota, 1987: Fig. 5C

Distribution.--Endemic to Lanyu Island (Fig. 7).

Remarks.--The species also belongs to Brown and Parker's (1977) Group III, and most closely resembles *L. balioburius* from Batan Island in the northern Philippines (Ota, 1987; Ota and Crombie, 1989).

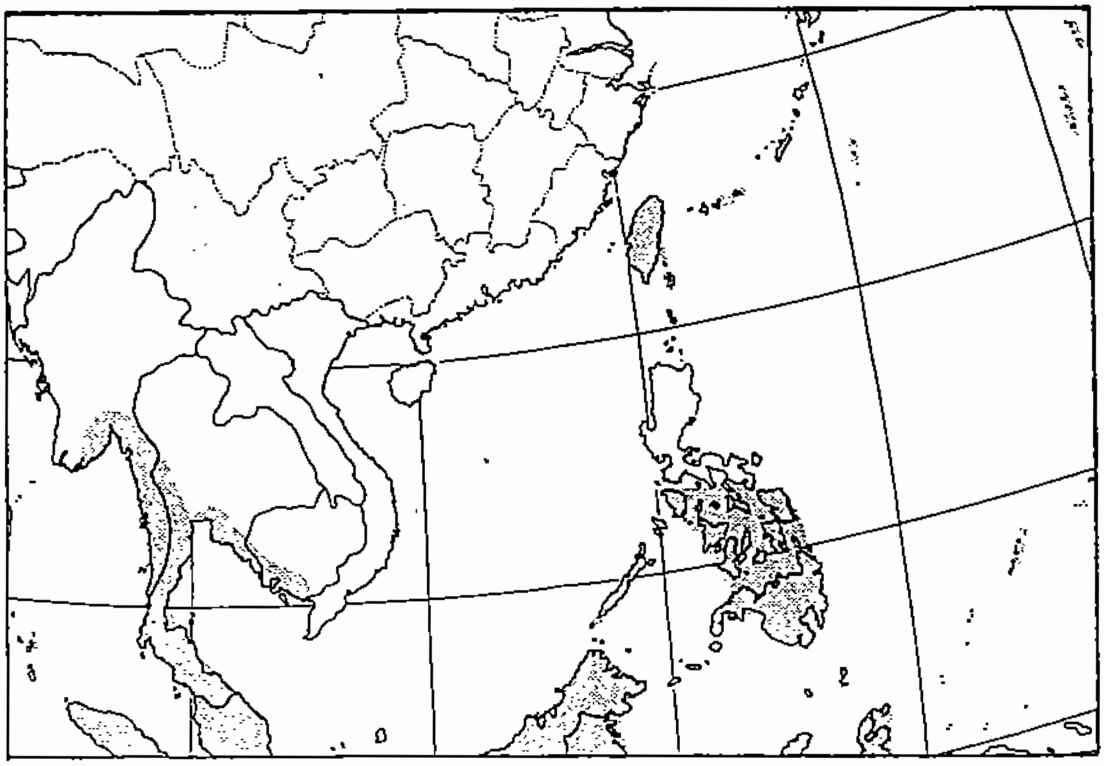


Fig. 7. A map of East and Southeast Asia showing ranges of *Lepidodactylus lugubris* (stippled area) and *L. yami* (vertically hatched area). The range of *L. balioburius*, the possible closest relative of the latter, is also indicated with horizontal hatches.

Genus *Hemiphyllodactylus* Bleeker, 1860

Distribution.--South, Southeast and East Asia, southern continental China, and the Pacific islands (Wermuth, 1965).

Hemiphyllodactylus typus Bleeker, 1860

Distribution.--South, Southeast and East Asia, and the Pacific islands (Wermuth, 1965).

Remarks.--Four subspecies are recognized (Auffenberg, 1980; Ota, 1990).

Hemiphyllodactylus typus typus Bleeker, 1860: Fig. 5D

Distribution.--The main-island, and Lutao and Lanyu Islands (Lue et al., 1987b; Ota and Ross, 1990). Known also from the southern Ryukyus, Southeast Asia and Pacific islands (Ota, 1990; Wermuth, 1965: Fig. 8).

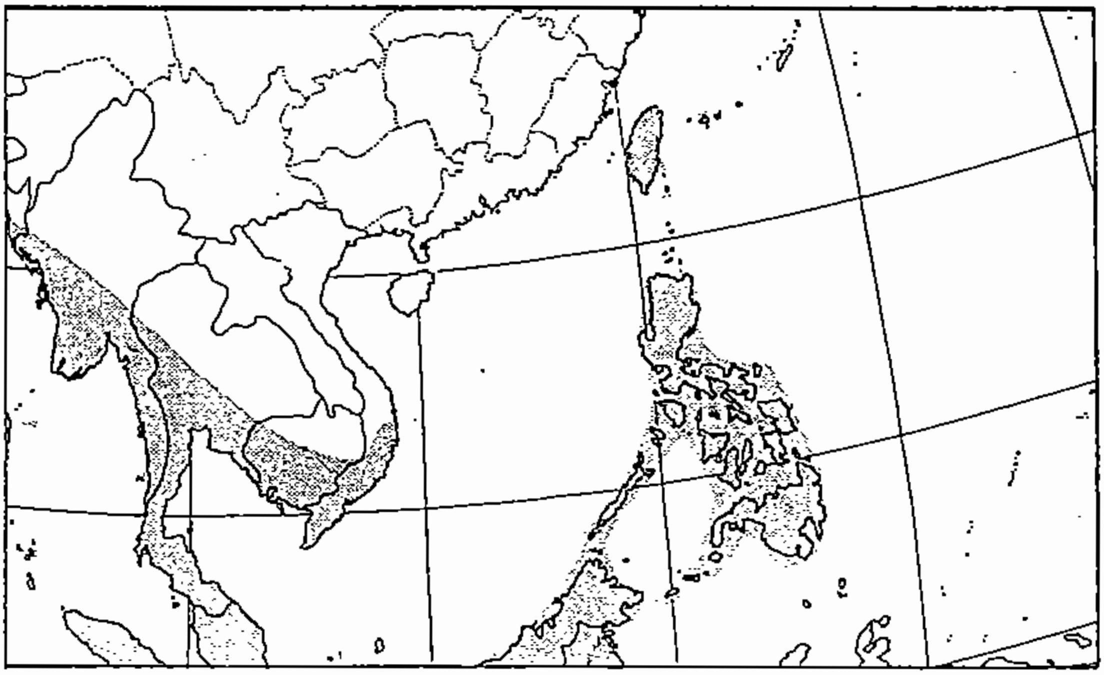


Fig. 8. A map of East and Southeast Asia showing the range of *Hemiphyllodactylus typus typus* (stippled area).

Genus *Hemidactylus* Oken, 1817

Distribution.--Tropical, subtropical and partially temperate regions around the world (Wermuth, 1965).

Remarks.--More than 80 species are so far reported.

Hemidactylus frenatus Duméril et Bibron, 1836

Distribution.--All around Taiwan including Lanyu and Lutao Islands but exclusive of high altitude areas and the northernmost part of the main-island. Known also from the Ryukyu Archipelago, southeastern continental China. Southeast Asia, and the northern Australia (Wermuth, 1965: Fig. 9).

Hemidactylus bowringii (Gray, 1845)

Distribution.--All around the main-island exclusive of high altitude areas. Known also from the Ryukyu Archipelago, southern continental

China, northern Indochina, Nepal and the northern India (Wermuth, 1965: Fig. 9).

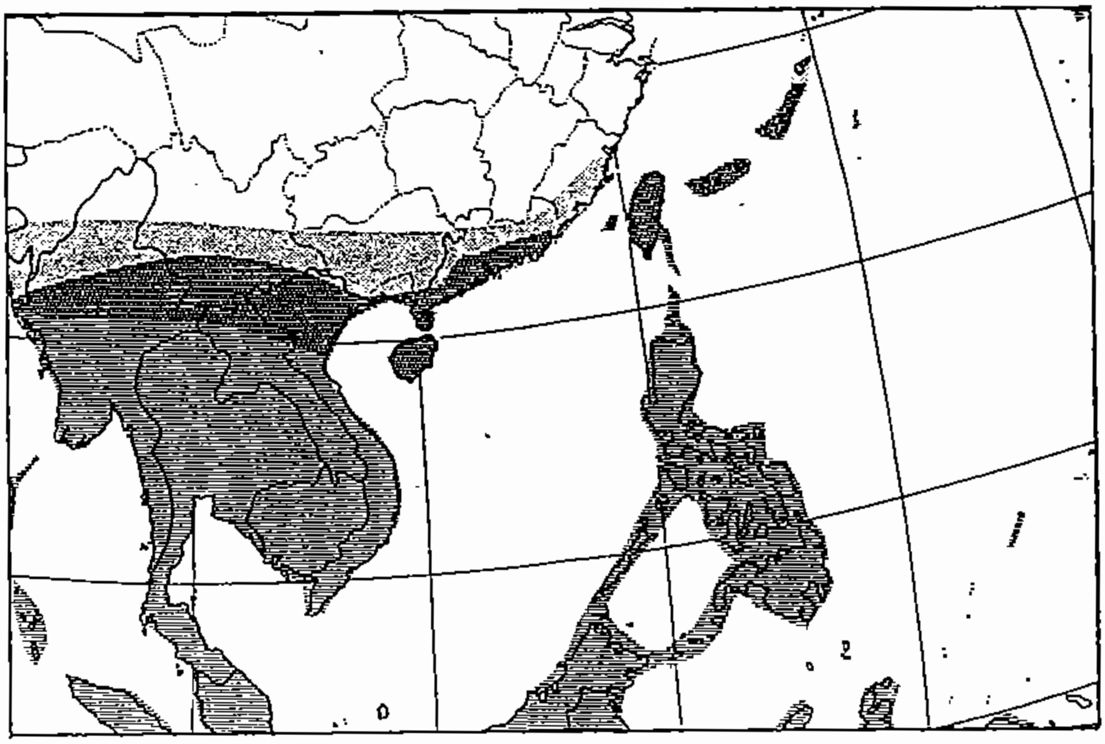


Fig. 9. A map of East and Southeast Asia showing ranges of *Hemidactylus frenatus* (horizontally hatched area) and *H. bowringii* (stippled area).

Hemidactylus stejnegeri Ota et Hikida, 1989: Fig. 5E

Distribution.--The main-island. Recently recorded from the northern Philippines, too (Ota and Hikida, 1989a). It is, however, impossible at present to outline the range of this species outside Taiwan, due to the lack of the chromosomal data for *Hemidactylus garnotii-vietnamensis* complex in the adjacent regions (Ota and Hikida, 1989b; Ota et al., 1986).

Remarks.--*H. stejnegeri* is triploid, parthenogenetic species, and exhibits chromosomal differentiations within Taiwan, as well as between Taiwan and the Philippines (Ota and Hikida, 1989a, b; Ota et al., 1989b).

Family Lacertidae Gray, 1825

Genus *Takydromus* Daudin, 1802

Distribution.--Southeast and East Asia, but excluding the Philippines and the eastern Indonesia.

Takydromus kuehnei Van Denburgh, 1909

Distribution.--The main-island. Known also from the southeastern continental China (Fig. 10).

Remarks.--The species had long been assigned to *Platyplacopus* Boulenger, 1917 (Lin and Cheng, 1980). The genus, however, was synonymized with *Takydromus* by Arnold (1989).

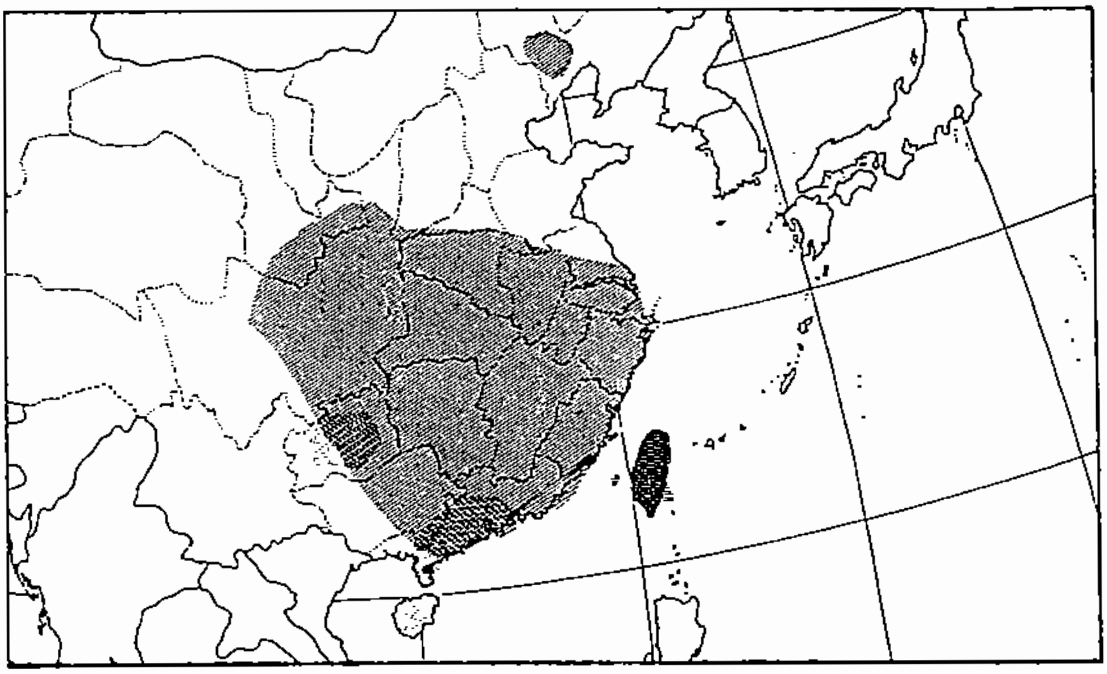


Fig. 10. A map of East and Southeast Asia showing ranges of *Takydromus kuehnei* (stippled area), *T. stejnegeri* (horizontally hatched area) and *T. formosanus* (vertically hatched area). The range of *T. septentrionalis*, the possible closest relative of the latter two species is also indicated with oblique hatches.

Takydromus formosanus Boulenger, 1894

Distribution.-- Endemic to the main-island (Fig. 10).

Remarks.--Closely resembling *T. stejnegeri* and *T. septentrionalis* (Boulenger, 1920; Cheng, 1987b).

Takydromus stejnegeri Van Denburgh, 1912: Fig. 11A

Distribution.--Endemic to Taiwan (Fig. 10).

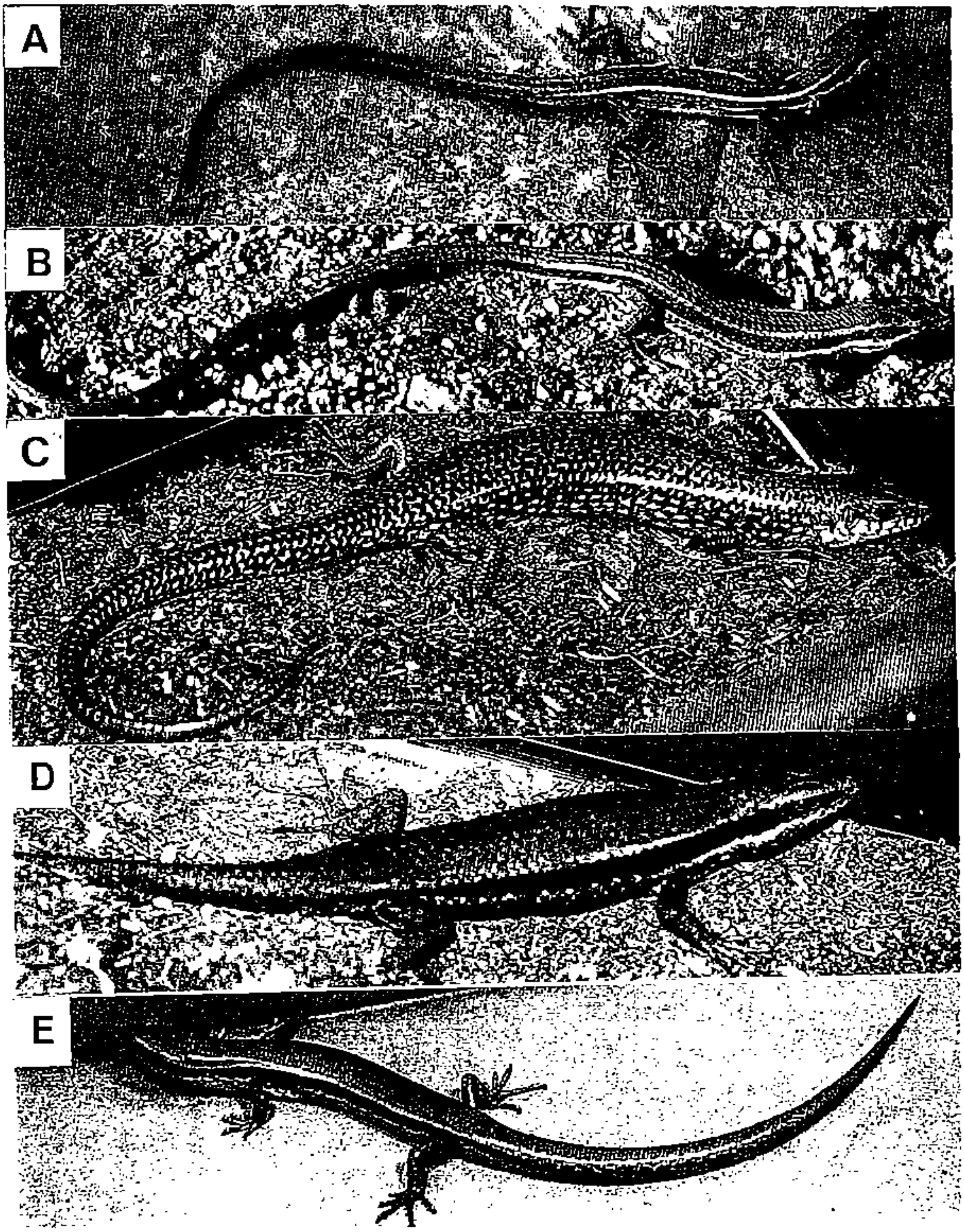


Fig. 11. Photographs of recently discovered or taxonomically poorly known lacertids and scincids from Taiwan. A: *Takydromus stejnegeri*. B: *T. hsuehshanensis*. C: *Eumeces chinensis leucostictus*. D: *Mabuya multicarinata borealis*. E: *Sphenomorphus taiwanensis*.

Remarks.--*T. stejnegeri* had long been regarded as a junior synonym of *T. septentrionalis*. Based on morphological comparisons between samples from Taiwan and the continent, Cheng (1987b) resurrected the former as a valid species.

Takydromus sauteri Van Denburgh, 1909

Distribution.--Endemic to the southern part of the main-island and Lanyu Island (Fig. 10).

Remarks.--The relationship of *T. sauteri* with other congeneric species is an open question for future studies.

Takydromus hsuehshanensis (Lin et Cheng), 1981: Fig. 11B

Distribution.--Known only from the high altitude area of the main-island (Fig. 12)

Remarks.--The species is probably closely allied to *T. tachydromoides*, *T. wolteri* and *T. amurensis* (Lin and Cheng, 1981).

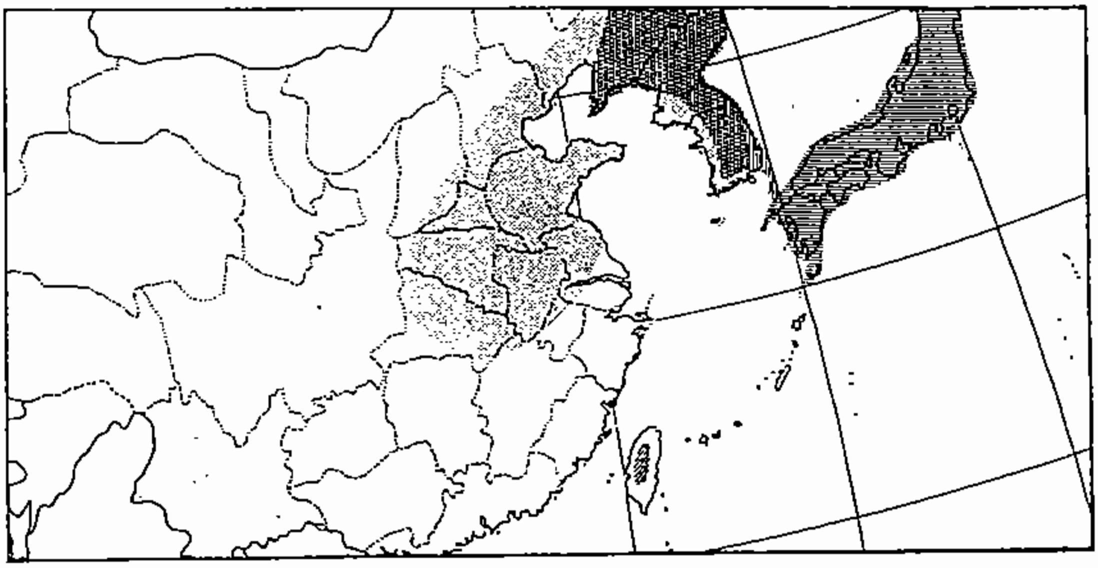


Fig. 12. A map of East and Southeast Asia showing the range of *Takydromus hsuehshanensis* (obliquely hatched area). Ranges of *T. wolteri*, *T. amurensis* and *T. tachydromoides*, the possible closest relatives of *T. hsuehshanensis*, are also indicated with stipples, and vertical and horizontal hatches, respectively.

Family Scincidae Gray, 1825

Genus *Eumeces*

Distribution.--Eurasia (exclusive of tropical region), and North and Central America.

Eumeces elegans Boulenger, 1887

Distribution.--The main-island and Penghu Islands. Known also from the southeastern continental China (Fig. 13).

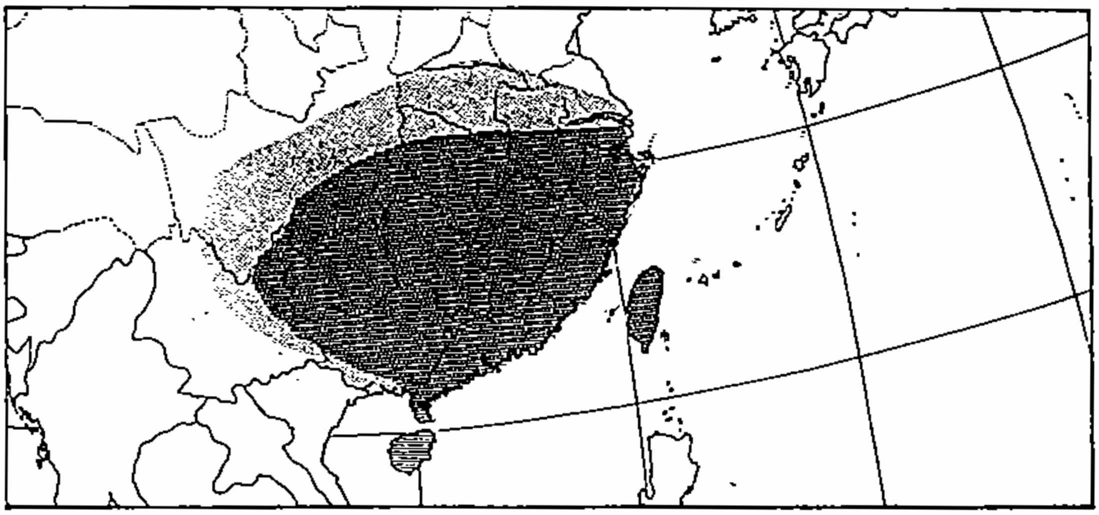


Fig. 13. A map of East and Southeast Asia showing ranges of *Eumeces elegans* (stippled area), *E. chinensis chinensis* (horizontally hatched area), and *E. c. leucostictus* (vertically hatched area).

Eumeces chinensis (Gray, 1838)

Distribution.--The main-island and Lutao Island. Known also from the southeastern continental China (Fig. 13).

Remarks.--Two subspecies, *E. c. chinensis* and *E. c. leucostictus*, are known from Taiwan. Hikida (1988), based on the preliminary analyses of geographic variation in *E. chinensis*, elucidated slight differences between the continental and Taiwanese populations in scale characters. He, however, defered the conclusion regarding the validity of *E. c. formosensis* described by Van Denburgh (1912) as an endemic subspecies of the main-island.

Eumeces chinensis chinensis (Gray, 1838)

Distribution.--The main-island and the southeastern continental China (Fig. 13).

Eumeces chinensis leucostictus Hikida, 1988: Fig. 11C

Distribution.--Endemic to Lutao Island (Fig. 13).

Remarks.--This subspecies differs from the others in scutellation and juvenile dorsal pattern, and may possibly be most closely related to the main-island population (Hikida, 1988).

Genus *Emoia* Gray, 1845

Distribution.--Southeast Asia, Australia and the Pacific islands.

Emoia atrocostata (Lesson, 1831)

Distribution.--Southeastern coast of the main-island and Lanyu Island. Widely distributed in the insular region of Southeast Asia, the western Pacific islands, and the Miyako Group of the southern Ryukyus (Fig. 14).

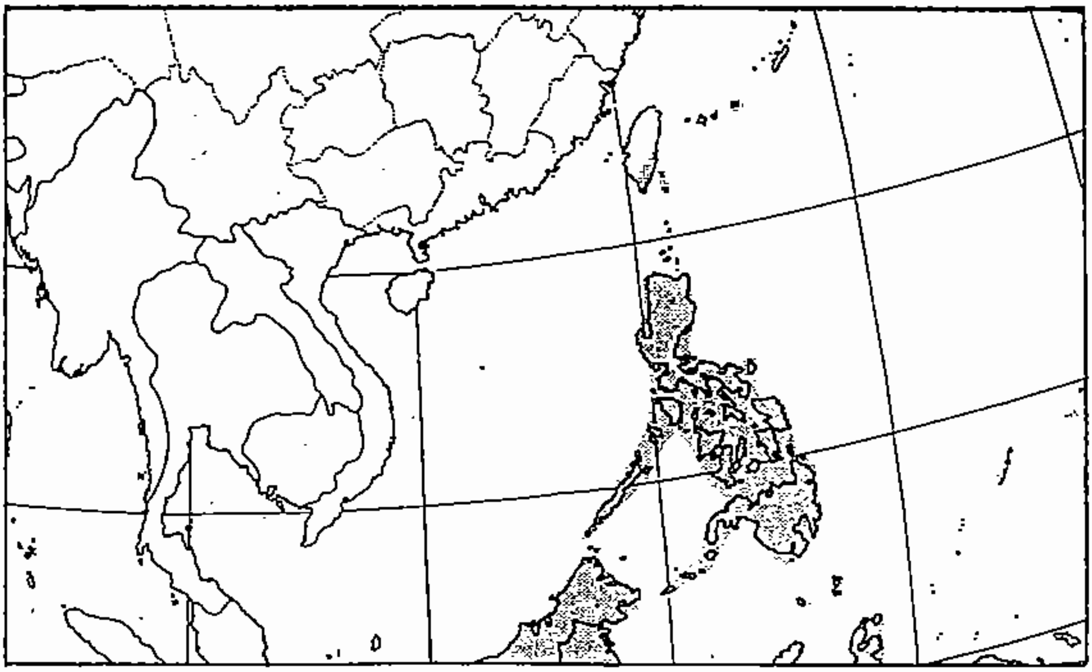


Fig. 14. A map of East and Southeast Asia showing the range of *Emoia atrocostata* (stippled area).

Genus *Mabuya* Fitzinger, 1826

Distribution.--Tropical and subtropical regions of Asia, Africa, and South America.

Mabuya longicaudata (Hallowell, 1857)

Distribution.--The main-island, and Lanyu and Lutao Islands. Known also from the southeastern continental China, Indochina, and Malay Peninsula (Fig. 15).

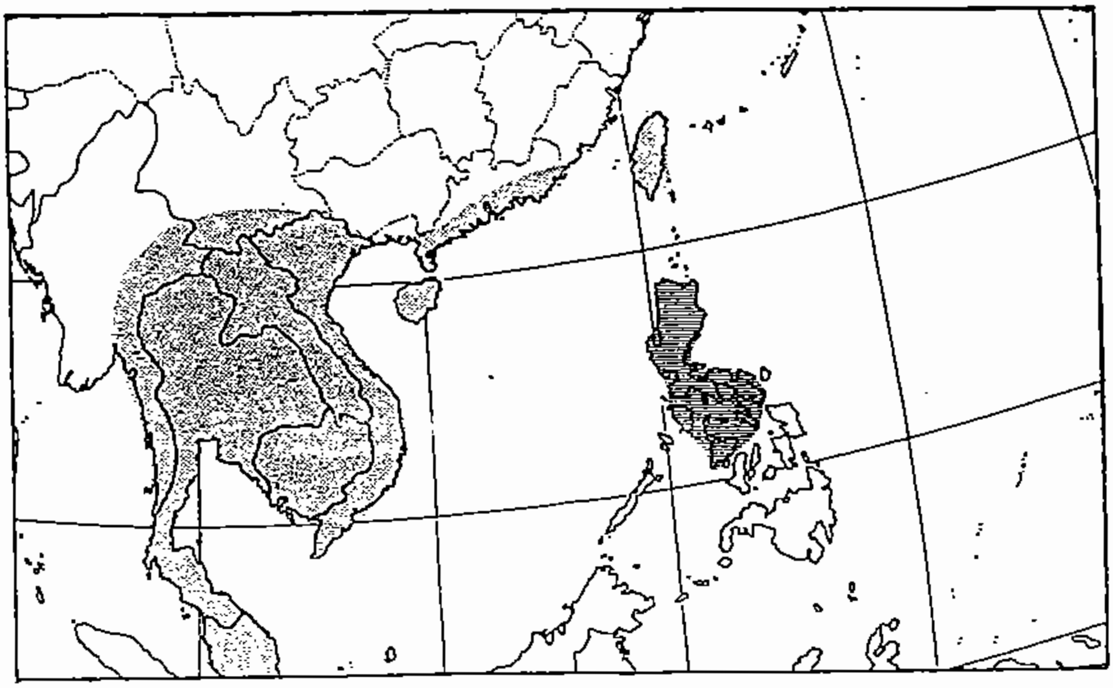


Fig. 15. A map of East and southeast Asia showing ranges of *Mabuya longicaudata* (stippled area) and *M. multicarinata borealis* (horizontally hatched area).

Mabuya multicarinata (Gray, 1845)

Distribution.--Philippine Islands and adjacent regions.

Mabuya multicarinata borealis Brown et Alcala, 1980: Fig. 11D

Distribution.--Lanyu Island. Know also from the northern half of the Philippines (Fig. 15).

Remarks.--Chen (1984) listed *M. multicarinata* as occurring on Lanyu Island for the first time. Later, Cheng (1987c) provided detailed description of specimens from the island. Lin and Cheng (1990) noted the possible morphological differentiations between Lanyu and Philippine populations. They, however, did not refer to the analysis of variation of the Philippine populations by Brown and Alcala (1980), which resulted in the subspecific division of the species. I compared available specimens from Lanyu Island and those of *M. m. borealis* from the northern Philippines, and found no significant differences between them (Ota, 1991d).

Genus *Scincella* Mittleman, 1950

Distribution.--South and Southeast Asia, and the southeastern North America (Greer, 1974).

Remarks.--Ouboter (1986) reviewed Asian species of the genus taxonomically, and assigned all populations from East Asia (including Taiwan, Ryukyu Archipelago, Korea and Tsushima Island of Japan) to *S. modesta*. However, the number and size of samples used for the analyses were too small, and he did not examine specimens from the insular regions at all. My unpublished data, as well as those provided by Takenaka (1987), do not support this conclusion. Wang and Zhao (1986), on the other hand, reviewed the Chinese species of *Scincella*, but did not refer to the population from Taiwan. Although the Taiwanese population closely resembles *S. modesta* from the southeastern part of the continent, some differences are recognizable between them (Ota, unpubl.). Thus, I here treat the Taiwanese population as an endemic species.

Scincella formosensis (Van Denburgh, 1912)

Distribution--Endemic to the main-island (Fig. 16).

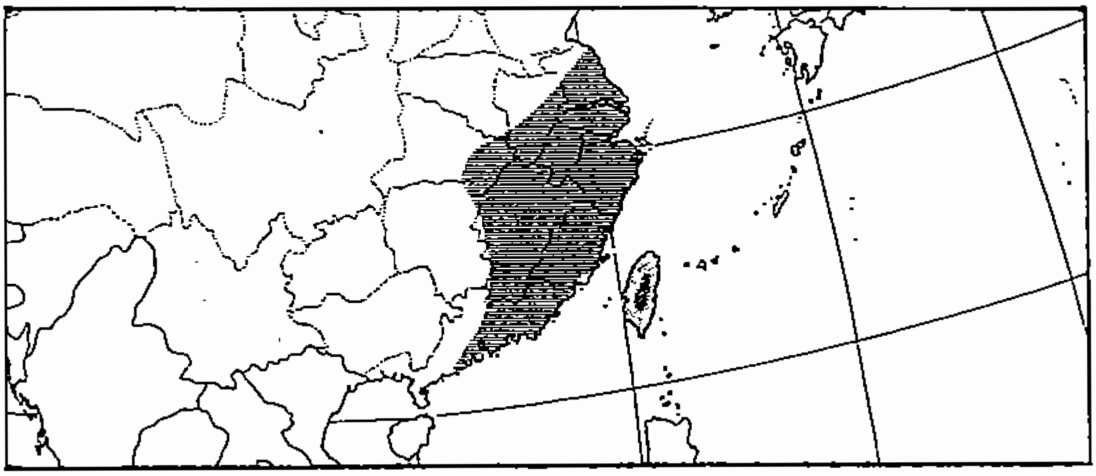


Fig. 16. A map of East and Southeast Asia showing ranges of *Scincella formosensis* (stippled area) and *Sphenomorphus taiwanensis* (vertically hatched area). The range of *Scincella modesta*, the possible closest relative of the former, is also indicated with horizontal hatches.

Genus *Sphenomorphus* Fitzinger, 1843

Distribution.--South and Southeast Asia, islands of the West Pacific, and Australia (Greer, 1974).

Remarks.--An extremely heterogenious and diversified group (Greer, 1974, 1979; Brown and Alcala, 1980), and its monophyly is an open question for future studies.

Sphenomorphus taiwanensis Chen and Lue, 1987: Fig. 11E

Distribution.--Restricted to the high altitudes of the main-island (Fig. 16).

Remarks.--Chen and Lue (1987) compared *S. taiwanensis* with others, and noted the resemblance of the species with *S. courcyanum* from Himalaya and *S. helenae* from Indochina on the basis of literature description.

Sphenomorphus boulengeri Van Denburgh, 1912

Distribution.--The main-island, and Lanyu and Lutao Islands. Known also from the southeastern continental China (Fig. 17).

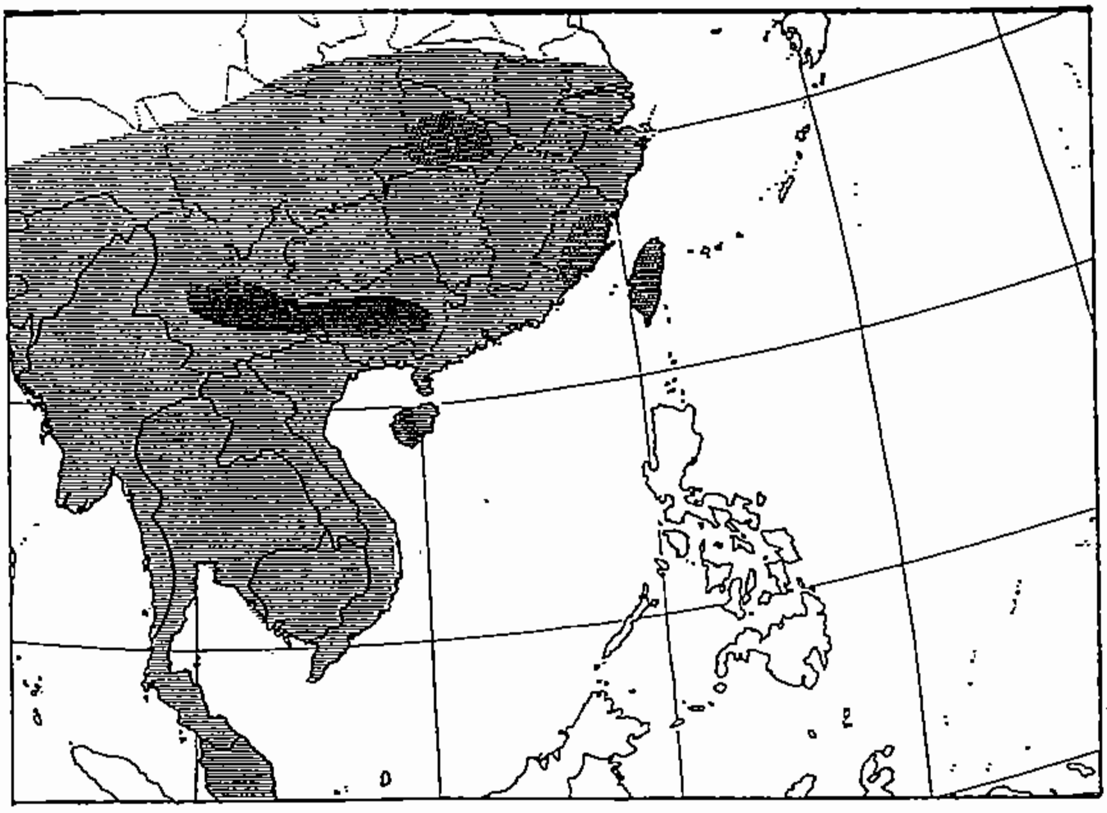


Fig. 17. A map of East and Southeast Asia showing ranges of *Sphenomorphus boulengeri* (stippled area) and *S. indicus* (horizontally hatched area).

Remarks.--Okada (1939) synonymized *boulengeri* with *indicus*, and Wang and Wang (1956) followed this account. Wang (1962), however, re-evaluated the validity of the former and revised its diagnosis by comparing specimens from Lanyu Island with *S. indicus*.

Sphenomorphus indicus (Gray, 1853)

Distribution--The main-island. Known also from South and Southeast Asia, and the southern and the eastern continental China (Fig. 17).

Family Anguidae Gray, 1825

Genus *Ophisaurus* Daudin, 1803

Distribution.--South, Southeast and East Asia, North and Central America, and Mediterranean coasts of Africa and Europe.

Ophisaurus formosensis Kishida, 1930

Distribution.--Endemic to the main-island (Fig. 18).

Remarks.--Closely resembling *O. harti*. Its relationships with other species remain unknown, however (Brygoo, 1987).

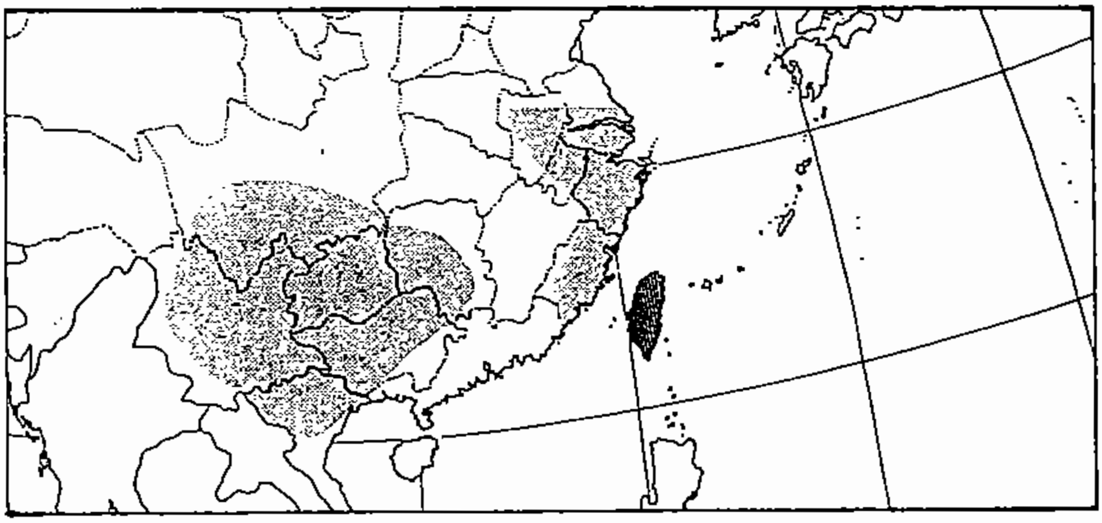


Fig. 18. A map of East and Southeast Asia showing ranges of *Ophisaurus harti* (stippled area) and *O. formosensis* (vertically hatched area).

Ophisaurus harti Boulenger, 1899

Distribution.--The main-island, the southern and the eastern continental China, and the northern Indochina (Fig. 18).

Family Varanidae Gray, 1827

Genus *Varanus* Merrem, 1820

Distribution.--Tropical and subtropical regions of the Old World.

Varanus salvator (Laurent, 1768)

Distribution.--The main-island. Widely distributed in South and Southeast Asia, and the southern and the southeastern continental China.

Remarks.--The species was recorded from Taiwan on the basis of several specimens collected during the last decade. This seems to indicate the recent entry of this gigantic lizard into Taiwan possibly by means of artificial transportations with woods from the tropical Asia (Lin and Cheng, 1990).

Family Typhlopidae Merrem, 1820

Genus *Ramphotyphlops* Fitzinger, 1843

Distribution.--Represented by the range of *braminus* below.

Remarks.--The genus had long been considered as a junior synonym of *Typhlops*. Robb (1966) recognized two distinct types of hemipenes within the genus (*sensu lato*), and resurrected the generic name *Ramphotyphlops* to accommodate species characterized by whip-like hemipenis. McDowell (1974), while confirming Robb's (1966) partition of *Typhlops* and proposing several complementary diagnostic characters for the two genera, claimed that the generic name *Ramphotyphlops* is a junior synonym of *Typhlina* Wagler. Stimson et al. (1977), however, petitioned the International Commission on Zoological Nomenclature for conservation of *Ramphotyphlops* and suppression of *Typhlina*. The former name has generally been adopted ever since (e.g., Nussbaum, 1980; Williams and Wallach, 1989).

Ramphotyphlops braminus (Daudin, 1803)

Distribution.--The main-island and Lanyu Island. Widely distributed in tropical and subtropical regions around the world (Fig. 19).

Remarks.--*R. braminus* is an all female, parthenogenetic species with triploid karyotype (McDowell, 1974; Nussbaum, 1980; Ota et al., 1991; Wynn et al., 1987).

Genus *Typhlops* Schneider in Oppel, 1811

Distribution.--Africa, South and Southeast Asia, the southern continental China, and New Guinea (Hahn, 1980).

Typhlops koshunnensis Oshima, 1916

Distribution.--Endemic to the southern part of the main-island (Fig. 19).

Remarks.--This species has been represented by three specimens (Maki, 1931), but all seem to have been lost. Thus, its relationships with other congeners remain unknown at all.

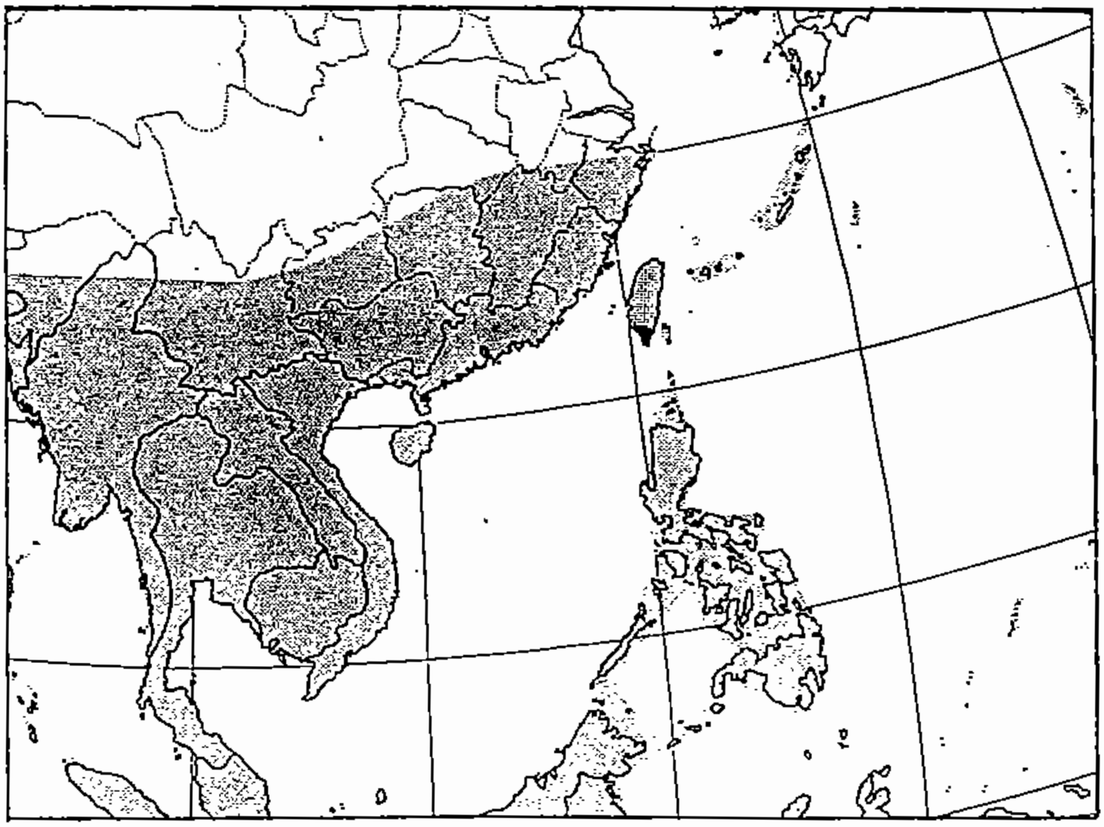


Fig. 19. A map of East and Southeast Asia showing ranges of *Ramphotyphlops braminus* (stippled area) and *Typhlops koshunnensis* (horizontally hatched area).

Family Colubridae Oppel, 1811

Genus *Achalinus* Peters, 1869

Distribution.--The northern Indochina, southeastern China, and Japan (Fig. 20).

Remarks.--Steindachner (1913) described *Achalinopsis* as an endemic genus of Taiwan on the basis of *A. sauteri*. However, the generic name and specific epithet were recently synonymized with *Achalinus* and *formosanus*, respectively, by Ota and Toyama (1989a).

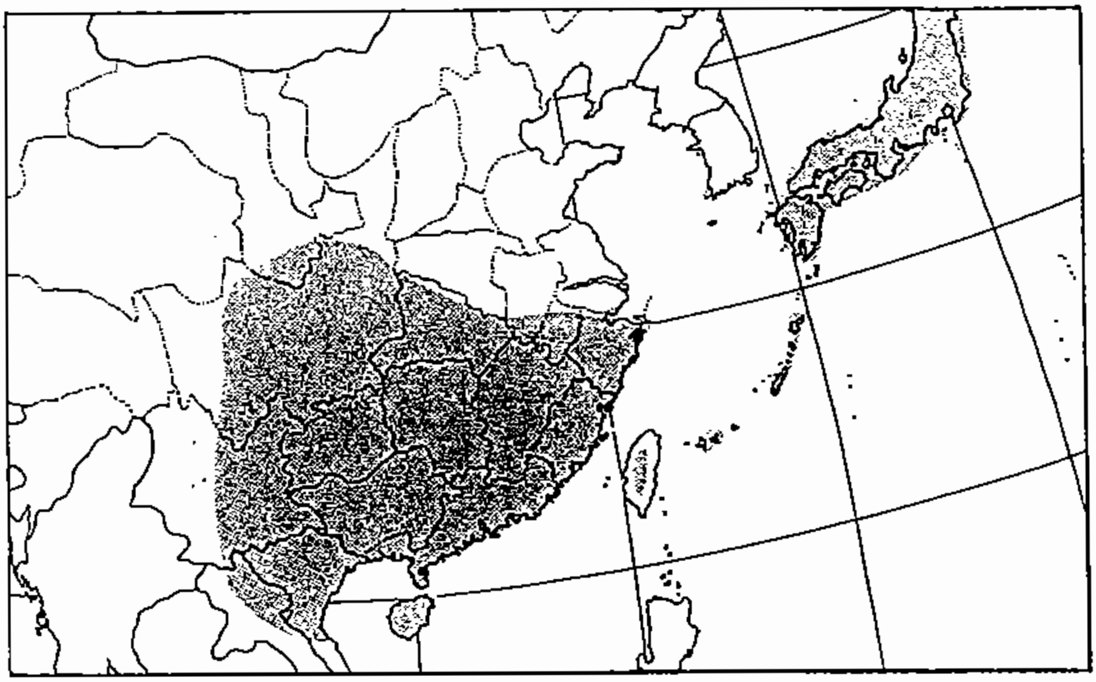


Fig. 20. A map of East and southeast Asia showing the range of the genus *Achalinus* (stippled area).

Achalinus formosanus Boulenger, 1908

Distribution.--The main-island. Known also from the southern Ryukyus (Ota and Toyama, 1989a, b).

Remarks.--Its relationships with other congeneric species remain obscure.

Achalinus formosanus formosanus Boulenger, 1908

Distribution.--Endemic to the high altitudes of the main-island.

Achalinus niger Maki, 1931

Distribution.--Endemic to the high altitudes of the main-island.

Remarks.--Its relationships with other congeneric species remain obscure.

Genus *Amphiesma* Duméril et al., 1854

Distribution.--South, Southeast and East Asia (Malnate, 1960; McDowell, 1984).

Remarks.--*Amphiesma*, as well as *Rhabdophis* and several other generic names, had long been regarded as junior synonyms of the widely distributed genus *Natrix*. Malnate (1960) reevaluated the validity of *Amphiesma* as a distinct genus to accommodate *stolata* (type species), *sauteri*, etc.

Amphiesma sauteri (Boulenger, 1909)

Distribution.--Northern Indochina and the southeastern China.

Remarks.--Malnate (1962) recognized three subspecies, of which the nominotypical one is distributed in Taiwan.

Amphiesma sauteri sauteri (Boulenger, 1909)

Distribution.--The main-island. Known also from the southeastern continental China. The population from Hainan Island may possibly be included in this subspecies, too (Fig. 21).

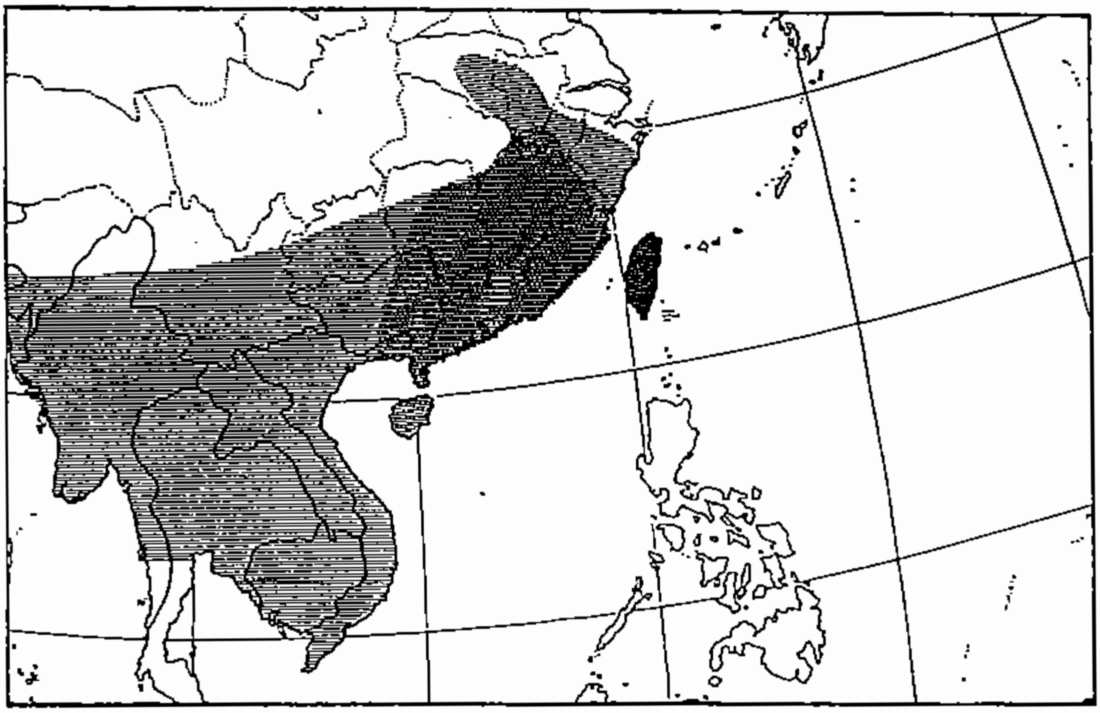


Fig. 21. A map of East and Southeast Asia showing ranges of *Amphiesma sauteri* (stippled area), *A. stolata* (horizontally hatched area), and *A. miyajimae* (vertically hatched area).

Amphiesma stolata (Linnaeus, 1758)

Distribution.--The main-island and Lanyu Island. Known also from Southeast Asia, and the southern and the southeastern continental China (Fig. 21).

Amphiesma miyajimae (Maki, 1931)

Distribution.--Endemic to the main-island (Fig. 21).

Remarks.--Zhao and Jiang (1986) first listed *miyajimae* as belonging to *Amphiesma*. This species closely resembles *A. stolata* [see Maki (1931)].

Genus *Boiga* Fitzinger, 1826

Distribution.--South, Southeast and East Asia.

Bioga kraepelini Stejneger, 1902

Distribution.--The main-island. Known also from the southeastern continental China (Fig. 22).

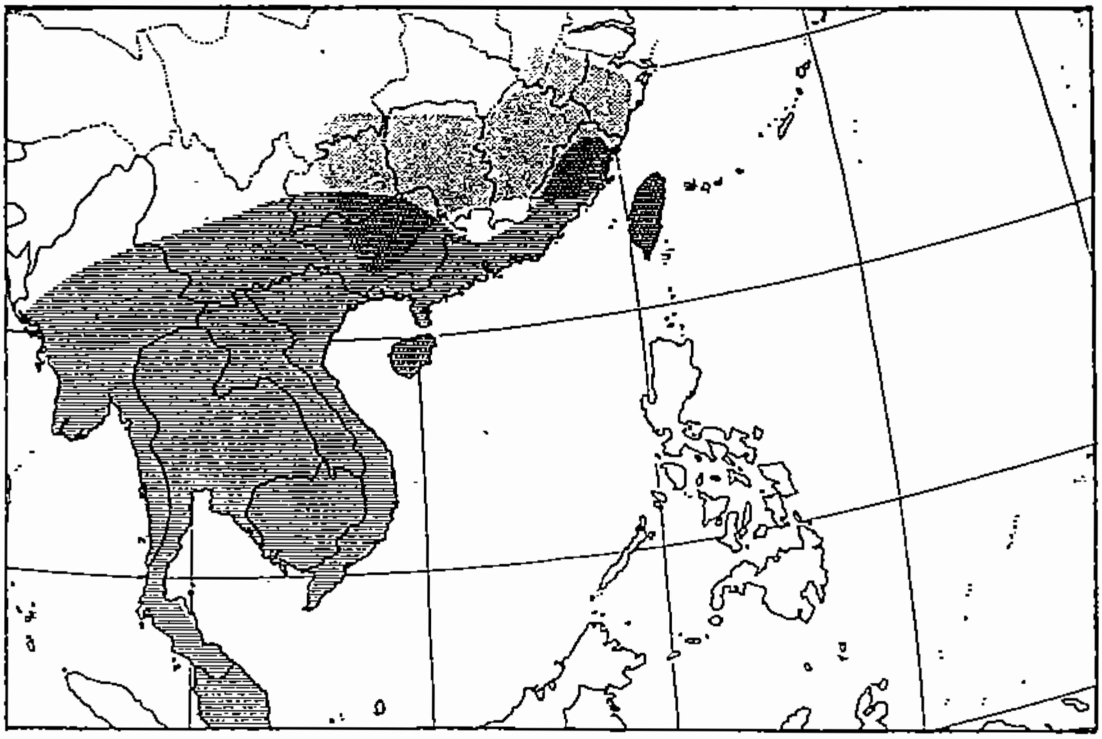


Fig. 22. A map of East and Southeast Asia showing ranges of *Boiga kraepelini* (stippled area) and *Calamaria pavimentata* (horizontally hatched area).

Genus *Calamaria* Boie, 1826

Distribution.--Southeast and East Asia (Inger and Marx, 1965).

Calamaria pavimentata Duméril et al., 1854

Distribution.--The main-island and Lanyu Island. Widely distributed in the southern Ryukyus, southeastern continental China, Indochina and Malay Peninsula (Fig. 22).

Remarks.--The Taiwanese population had been known as an endemic subspecies *C. p. formosana* Maki, 1931. However, Inger and Marx (1965), after examining specimens from various localities, negated the division of *C. pavimentata* into subspecies. I here follow their account, although it may still require future verifications (Ota, 1982).

Genus *Dinodon* Duméril, 1853

Distribution--Indochina and East Asia.

Remarks.--See *Lycodon* section below.

Dinodon rufozonatus (Cantor, 1842)

Distribution.--The northern Indochina and East Asia.

Remarks.--Two subspecies are recognized.

Dinodon rufozonatus rufozonatus (Cantor, 1842)

Distribution.--The main-island. Widely distributed in the northern Indochina, southeastern continental China, Korea, and Tsushima Island of Japan (Fig. 23).

Fig. 23. A map of East and southeast Asia showing the range of *Dinodon rufozonatus rufozonatus* (stippled area).

Genus *Elaphe* Fitzinger, 1833

Distribution.--Eurasia and North America.

Remarks.--A large, heterogeneous, and possibly polyphyletic group.

Elaphe carinata (Günther, 1864)

Distribution.--Northern Indochina, southeastern China and the southern Ryukyus.

Remarks.--*E. c. yonaguniensis* is known from the southern Ryukyus (Takara, 1962).

Elaphe carinata carinata (Günther, 1864)

Distribution.--The main-island, and Lanyu and Lutao Islands. Known also from the northern Indochina and the southeastern continental China (Fig. 24).

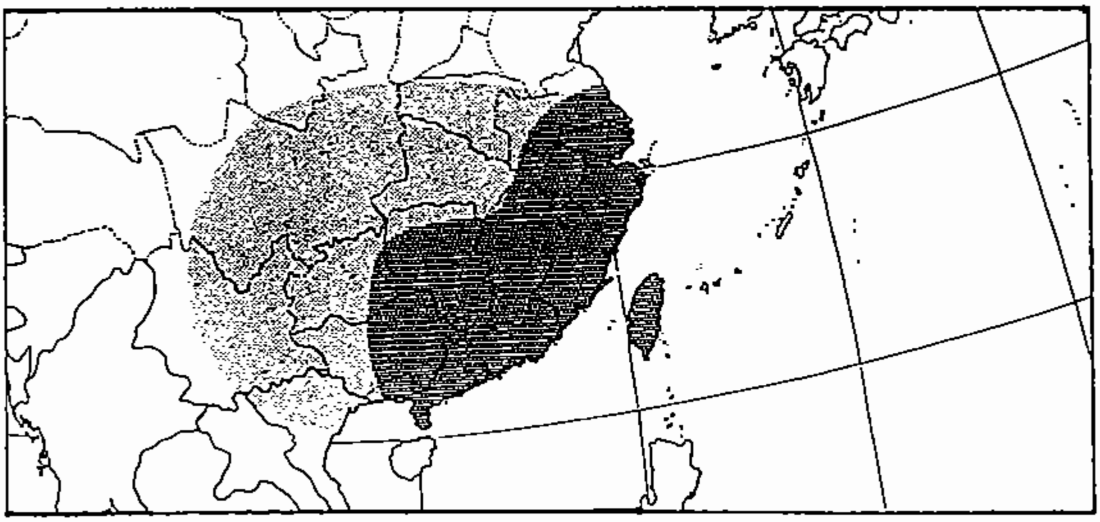


Fig. 24. A map of East and Southeast Asia showing ranges of *Elaphe carinata carinata* (stippled area) and *E. porphyracea nigrofasciata* (horizontally hatched area).

Elaphe porphyracea (Cantor, 1839)

Distribution.--Southeast Asia, and the southern and the southeastern China.

Elaphe porphyracea nigrofasciata (Cantor, 1839)

Distribution.--The main-island. Known also from the southeastern continental China (Fig. 24).

Elaphe mandarina (Cantor, 1842)

Distribution.--The northern Indochina and the southeastern continental China (Fig. 25).

Remarks.--Two subspecies are recognized.

Elaphe mandarina takasago Takahashi, 1930

Distribution.--Known only from the high altitude area of the main-island.

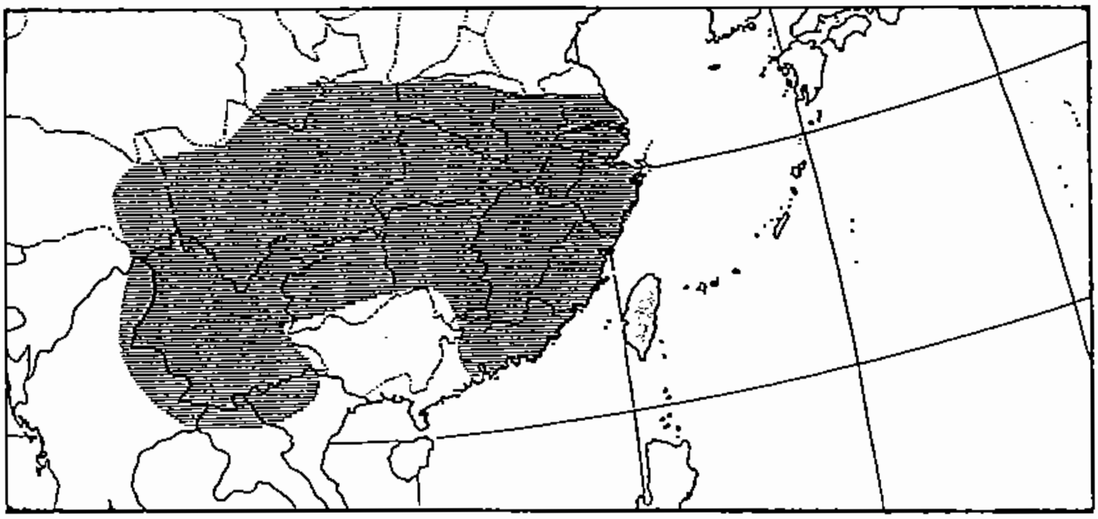


Fig. 25. A map of East and Southeast Asia showing the range of *Elaphe mandarina takasago* (stippled area). The range of the nominotypical subspecies is also indicated with horizontal hatches.

Elaphe taeniura Cope, 1861

Distribution.--Southeast and East Asia.

Elaphe taeniura friesei (Werner, 1926)

Distribution.--The subspecies is endemic to the main-island, but closely resembles the nominotypical subspecies that occurs in Indochina, and the southern and the eastern continental China (Fig. 26).

Genus *Enhydris* Latreille, 1802

Distribution.--South and Southeast Asia, and the southeastern China.

Enhydris chinensis (Gray, 1842)

Distribution.--The main-island. Known also from the northeastern Indochina and the southeastern continental China (Fig. 27).

Enhydris plumbea (Boie, 1827)

Distribution.--The main-island. Known also from the southeastern continental China, Indochina, Malay Peninsula and Sunda Archipelago (Fig. 27).

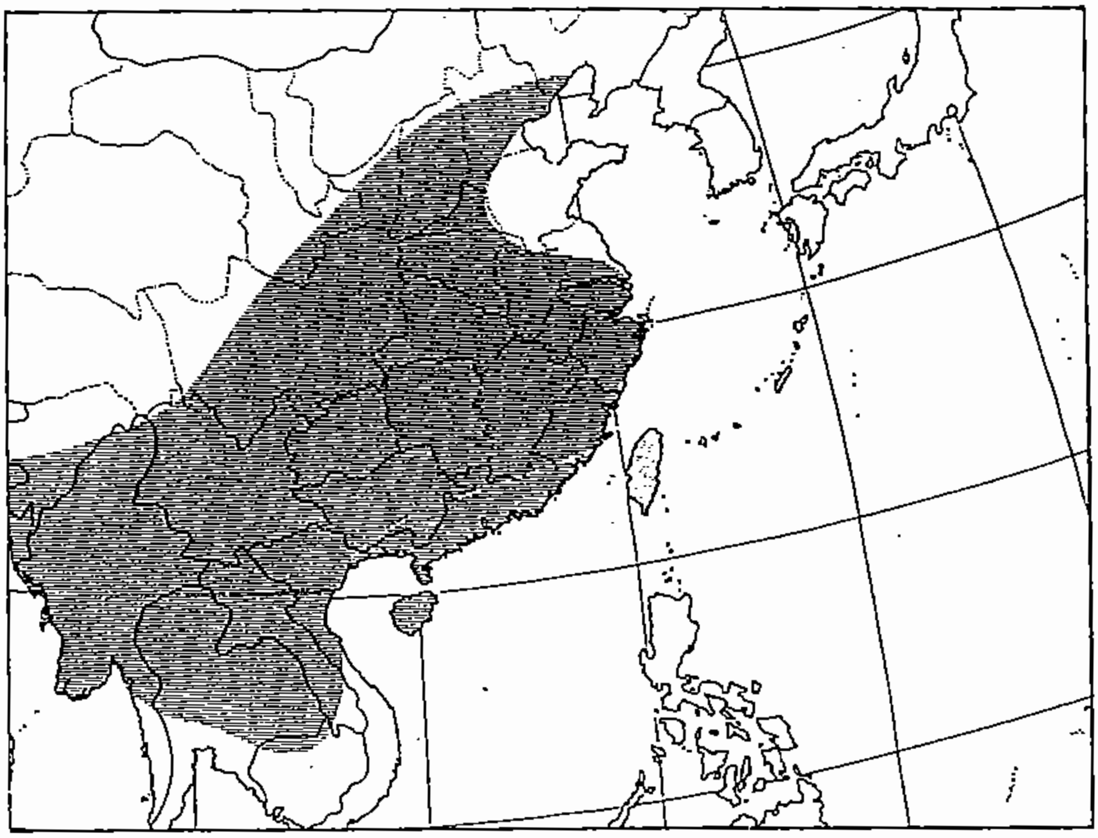


Fig. 26. A map of East and Southeast Asia showing the range of *Elaphe taeniura friesei* (stippled area). The range of the nominotypical subspecies is also indicated with horizontal hatches.

Genus *Cyclophiops* Boulenger, 1895

Distribution.--South, Southeast and East Asia.

Remarks.--Cundall (1981) resurrected the generic name, *Entechinus*, to accommodate six Asian species (including *major*) formerly assigned to the genus *Opheodrys*, chiefly on the basis of osteological features. Many recent authors have followed this account. However, Toriba (1989) claimed that the generic name, *Cyclophiops*, has a priority over *Entechinus*.

Cyclophiops major (Günther, 1858)

Distribution.--The main-island. Known also from the northern Indochina and the southeastern continental China (Fig. 28).

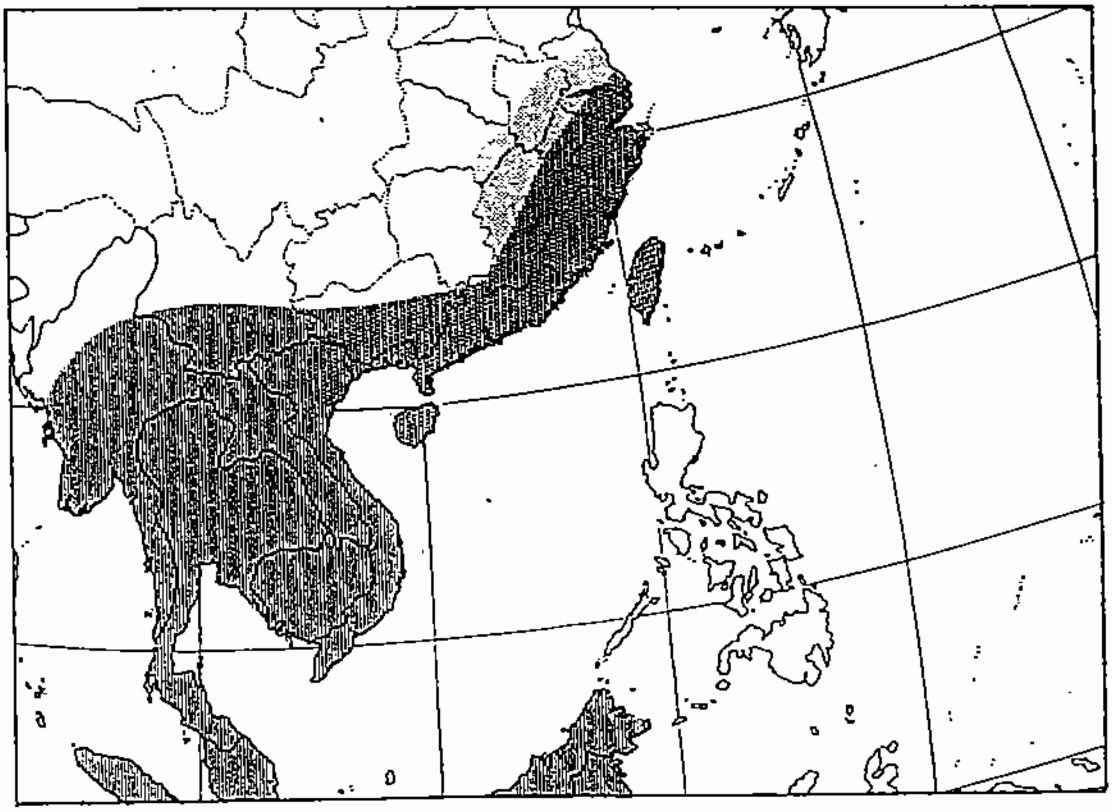


Fig. 27. A map of East and Southeast Asia showing ranges of *Enhydris chinensis* (stippled area) and *E. plumbea* (vertically hatched area).

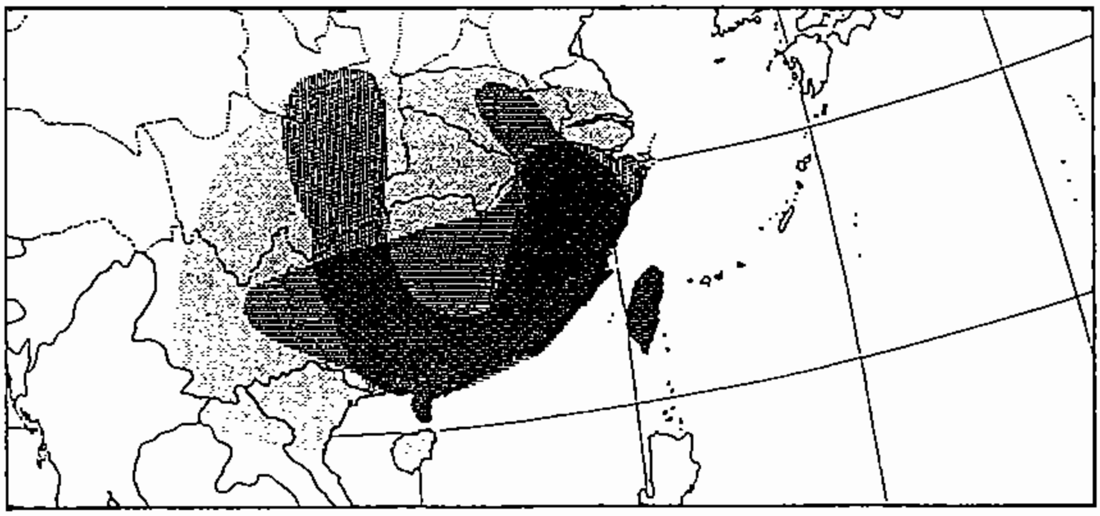


Fig. 28. A map of East and Southeast Asia showing ranges of *Entechinus major* (stippled area), *Lycodon ruhstrati ruhstrati* (vertically hatched area), and *Macropisthodon rudis rudis* (horizontally hatched area).

Remarks.--Maki (1931) described a subspecies, *bicarinata*, from a mountain of the main-island, which was considered to differ from the nominotypical subspecies chiefly by having keeled body scales in a few median rows. This character, however, seems to be highly variable within a sample from a single locality (Ota, unpubl.). Thus, I follow the invalidation of *bicarinata* by Mao (1964).

Genus *Lycodon* Boie, 1826

Distribution.--South, Southeast and East Asia.

Lycodon ruhstrati (Fischer, 1886)

Distribution.--Southeastern China.

Remarks.--The species had inadequately been treated as a subspecies of *Dinodon septentrionalis*. Two subspecies are recognized (Ota, 1988).

Lycodon ruhstrati ruhstrati (Fischer, 1886)

Distribution.--The main-island. Known also from the southeastern continental China (Fig. 28).

Remarks.--There may be some morphological differentiations between the Taiwanese and the continental populations (Ota, 1988).

Genus *Macropisthodon* Boulenger, 1893

Distribution.--South, Southeast and East Asia.

Macropisthodon rudis Boulenger, 1906

Distribution.--Southeastern China.

Remarks.--Wang and Wang (1956) listed *M. r. carinata* (Van Denburgh, 1909) as a subspecies endemic to Taiwan. I, however, found no significant differences between the samples from Taiwan and the continent.

Macropisthodon rudis rudis Boulenger, 1906

Distribution.--The main-island. Known also from the southeastern continental China (Fig. 28).

Genus *Oligodon* Boie, 1827

Distribution.--South, Southeast and East Asia.

Oligodon formosanus (Günther, 1872)

Distribution.--The main-island, and Lanyu and Lutao Islands. Known also from the northern Indochina and the southeastern continental China (Fig. 29).

Remarks.--The species was designated as the type of the genus *Holarchus* Cope, 1887 by Pope (1935), who provided definitions of *Holarchus* for its validity: he argued that the general morphology of hemipenis differs between *Oligodon* [*sensu* Pope (1935)] and *Holarchus*, and that variation in other characters coincides with this differences. However, as Pope (1935) also noted, it is difficult to divide *Oligodon* (*sensu lato*) into two groups clearly on the basis of hemipenial morphology. Thus, many recent authors regarded *Holarchus* as a junior synonym of *Oligodon* (e. g., Leviton, 1963a). Although *Oligodon* may possibly be divided into more than one natural groups in future, its division seems premature and I follow the latter account here.

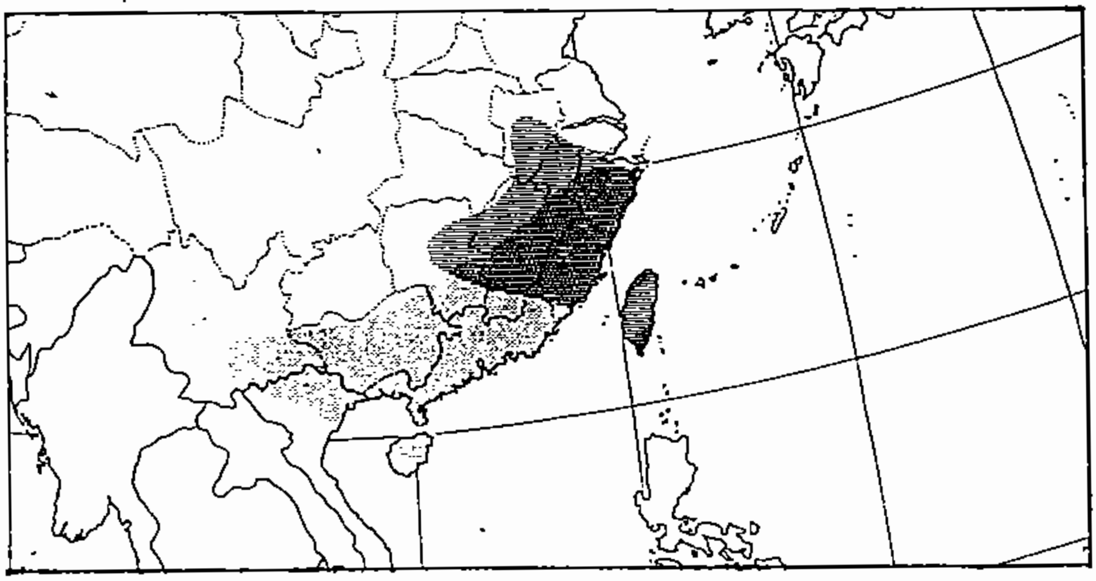


Fig. 29. A map of East and Southeast Asia showing ranges of *Oligodon formosanus* (stippled area) and *O. ornatus* (horizontally hatched area).

Oligodon ornatus Van Denburgh, 1909

Distribution.--The main-island. Also known from the eastern continental China (Fig. 29).

Genus *Pareas* Wagler, 1830

Distribution.--South, Southeast and East Asia.

Remarks.--The generic name, *Amblycephalus* Kuhl in Boie, 1827, is often used as the senior synonym of *Pareas*. The former is, however, a junior homonym of *Amblycephalus* Zedler, 1803, for Cestoda, and thus is suppressed (see Williams and Wallach, 1989).

Pareas formosensis (Van Denburgh, 1909)

Distribution.--Endemic to the main-island.

Remarks.--No information is available regarding its relationships with other congeneric species.

Pareas komaii (Maki, 1931)

Distribution.--Endemic to the main-island.

Remarks.--No information is available regarding its relationships with other congeneric species.

Genus *Psammodynastes* Günther, 1858

Distribution.--Represented by the range of *pulverulentus*.

Psammodynastes pulverulentus (Boie, 1827)

Distribution.--The main-island and Lanyu Island. Widely distributed in South, Southeast and East Asia (Fig. 30).

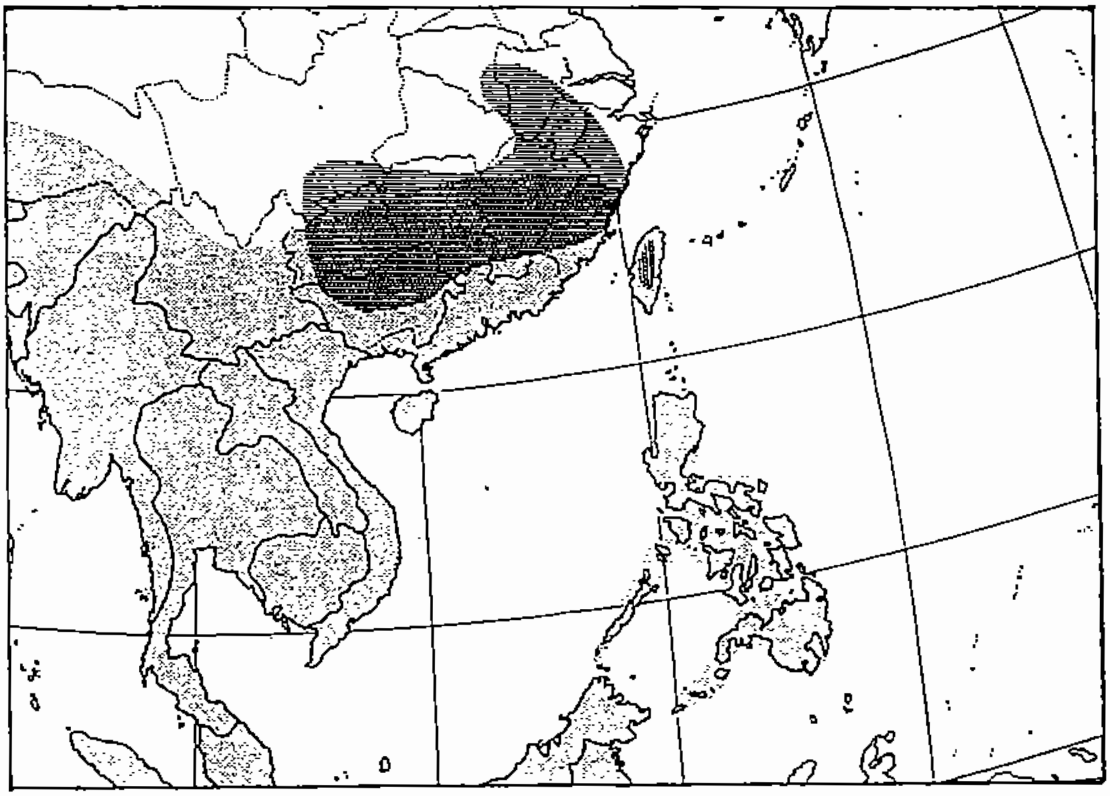


Fig. 30. A map of East and Southeast Asia showing ranges of *Psammodynastes pulverulentus* (stippled area) and *Pseudoxenodon stejnegeri stejnegeri* (vertically hatched area). The range of the other subspecies of *P. stejnegeri* (i.e., *P. s. striaticaudatus*: see the text) is also indicated with horizontal hatches.

Remarks.--Wang (1962) assumed the entry of this species to Taiwan from the Philippines. However, Rasmussen (1975), on the basis of analyses of variation using a large series of samples from various localities, rejected this assumption, and surmised that the Taiwanese population migrated from the continent.

Genus *Pseudoxenodon* Boulenger, 1890

Distribution.--South, Southeast and East Asia.

Remarks.--Classification of the species belonging to this genus is utter chaos, and revisional study is being performed (Ineich and Ota, in prep.).

Pseudoxenodon stejnegeri Barbour, 1908

Distribution.--East Asia (Fig. 30).

Pseudoxenodon stejnegeri stejnegeri Barbour, 1908

Distribution.--Endemic to the high altitudes of the main-island.

Remarks.--Taiwanese population is often treated as belonging to *P. macrops* or *nothus* (e. g., Chan, 1981; Chen, 1984; Lue, 1989). Recently, Toriba in Zhao (1983) pointed out that *stejnegeri* Baubour, 1908 from Taiwan bears a priority over *striaticaudatus* Pope 1928 from the continent, and the latter over *nothus* Smith, 1942. Thus, on the basis of the assumption that the three names are conspecific with each other and that the Taiwanese population differs from the continental population in the subspecific level, he proposed the designation of the Taiwanese population to be the nominotypical subspecies of *P. stejnegeri*. Despite that future verifications, using reasonable number and size of samples, are strongly required, I follow this account at present.

Genus *Ptyas* Fitzinger, 1843

Distribution.--Represented by the range of *mucosus*.

Ptyas mucosus (Linnaeus, 1758)

Distribution.--The main-island. Widely distributed in South, Southeast and East Asia (Fig. 31).

Ptyas korros (Schlegel, 1837)

Distribution.--The main-island. Widely distributed in Southeast and East Asia (Fig. 31).

Genus *Rhabdophis* Fitzinger, 1843

Distribution.--Southeast and East Asia.

Remarks.--See remarks on the genus *Amphiesma* above.

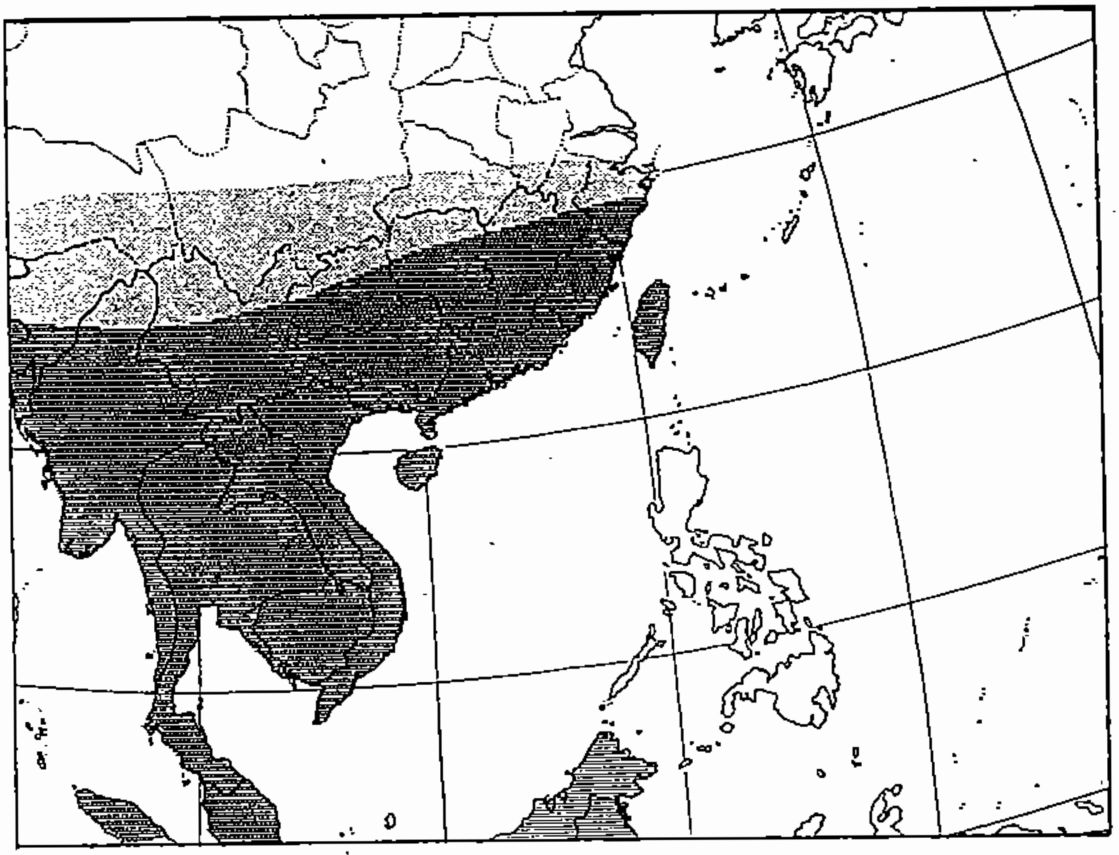


Fig. 31. A map of East and Southeast Asia showing ranges of *Ptyas mucosus* (stippled area) and *P. korros* (horizontally hatched area).

Rhabdophis swinhonis (Günther, 1868)

Distribution.--Endemic to the main-island.

Remarks.--No information is available regarding its relationships with other congeneric species.

Rhabdophis tigrinus (Boie, 1826)

Distribution.--Widely distributed in East Asia (Fig. 32).

Rhabdophis tigrinus formosanus (Maki, 1931)

Distribution.--Endemic to the high altitudes of the main-island (Ota and Mori, 1985).

Genus *Sibynophis* Fitzinger, 1843

Distribution.--South, Southeast and East Asia.

Sibynophis chinensis (Günther, 1889)

Distribution.--Southeastern part of China.

Remarks.--Zhao (1987) recognized three subspecies.

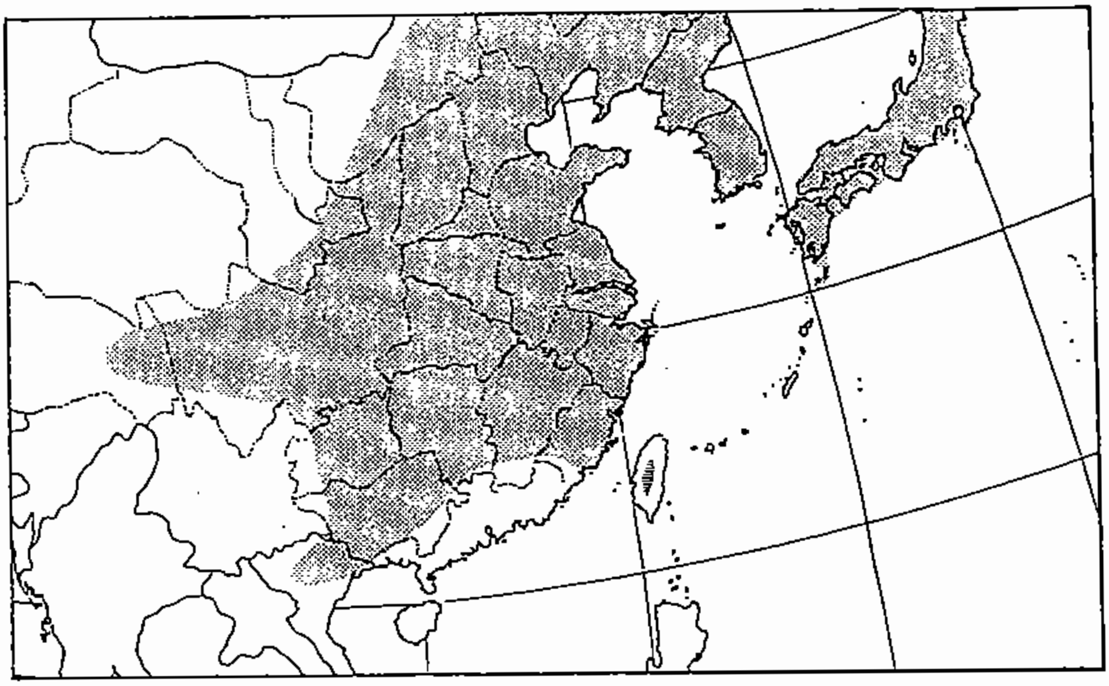


Fig. 32. A map of East and Southeast Asia showing the range of *Rhabdophis tigrinus formosanus* (stippled area). Ranges of the other subspecies are indicated with stipples.

Sibynophis chinensis chinensis (Günther, 1889)

Distribution.--The main-island. Known also from the southeastern continental China (Fig. 33).

Remarks.--Zhao (1987) assigned the Taiwanese population to the nominotypical subspecies.

Genus *Sinonatrix* Rossman et Eberle, 1977

Distribution.--South and Southeast Asia.

Remarks.--Rossman and Eberle (1977) recognized four natural groups in the genus *Natrix* [*sensu* Malnate (1960) and Malnate and Minton (1965)] each characterized by osteological, scutellational, hemipenial and karyological features. Thus, they resurrected *Nerodia*, and described *Afronatrix* and *Sinonatrix* to accommodate North American, African and Asian members, respectively. Zhao and Jiang (1986) listed *suriki* from Taiwan as a subspecies of *percarinata* from the continent, probably following Mao (1965a).

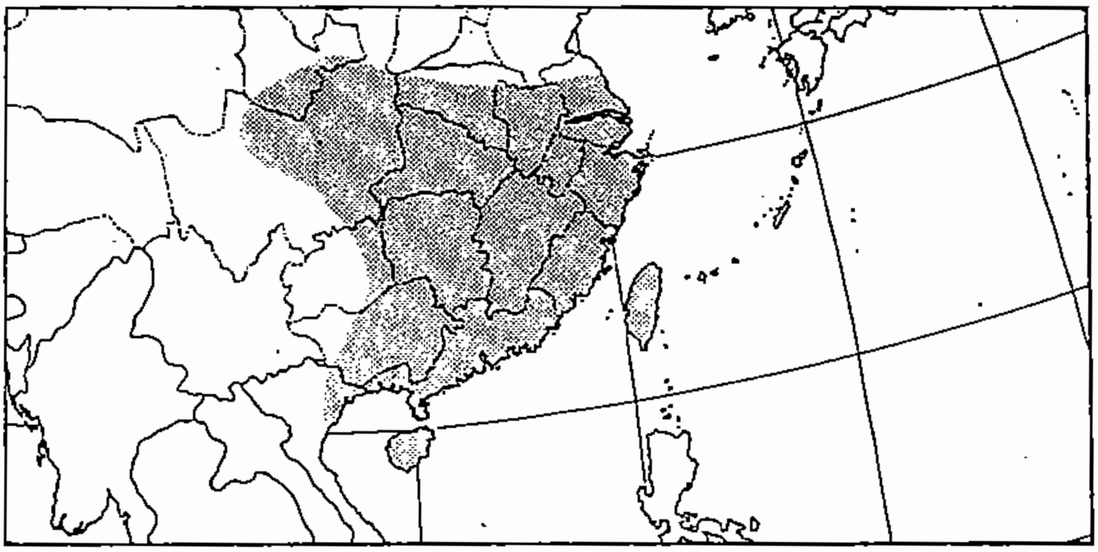


Fig. 33. A map of East and Southeast Asia showing the range of *Sibynophis chinensis chinensis* (stippled area).

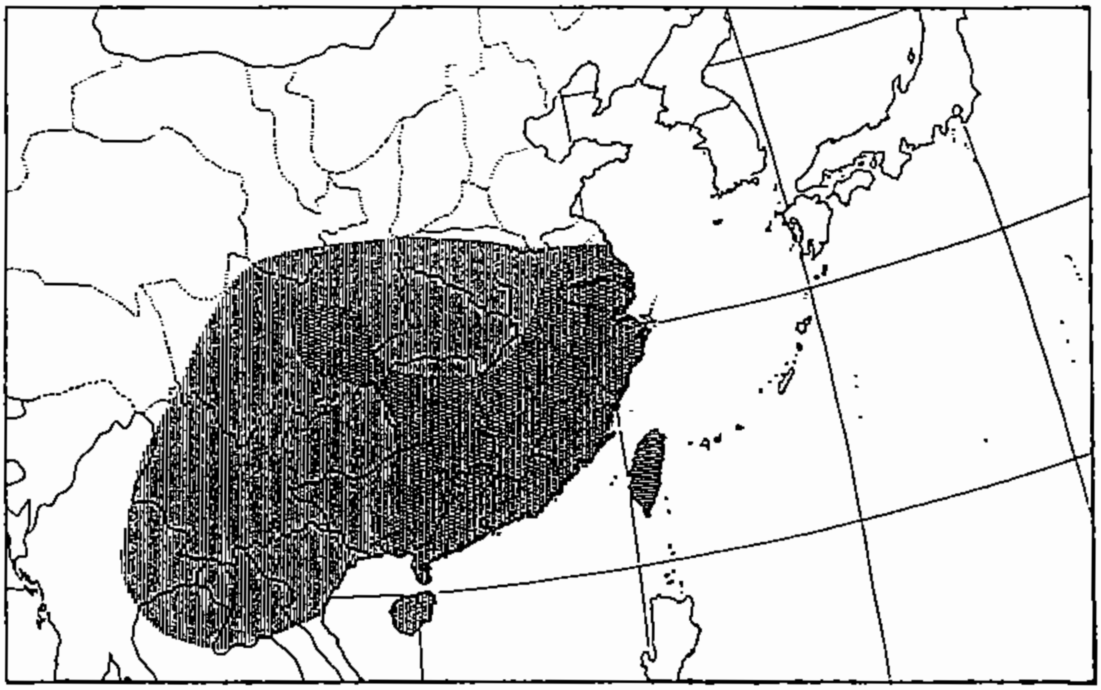


Fig. 34. A map of East and Southeast Asia showing ranges of *Sinonatrix annularis* (stippled area) and *S. percarinata suriki* (horizontally hatched area). The range of the nominotypical subspecies of the latter is also indicated with vertical hatches.

Sinonatrix annularis (Hallowell, 1856)

Distribution.--The main-island. Known also from the southeastern continental China (Fig. 34).

Sinonatrix percarinata (Boulenger, 1899)

Distribution.--Southeastern China (Fig. 34).

Sinonatrix percarinata suriki (Maki, 1931)

Distribution.--Endemic to the main-island.

Genus *Xenochrophis* Günther, 1864

Distribution.--Represented by the range of *piscator* below.

Remarks.--Malnate and Minton (1965) rearranged the genus, formerly considered to be monotypic, to accommodate several species including *piscator*.

Xenochrophis piscator (Schneider, 1799)

Distribution.--The main-island. Widely distributed in South, Southeast and East Asia (Fig. 35).

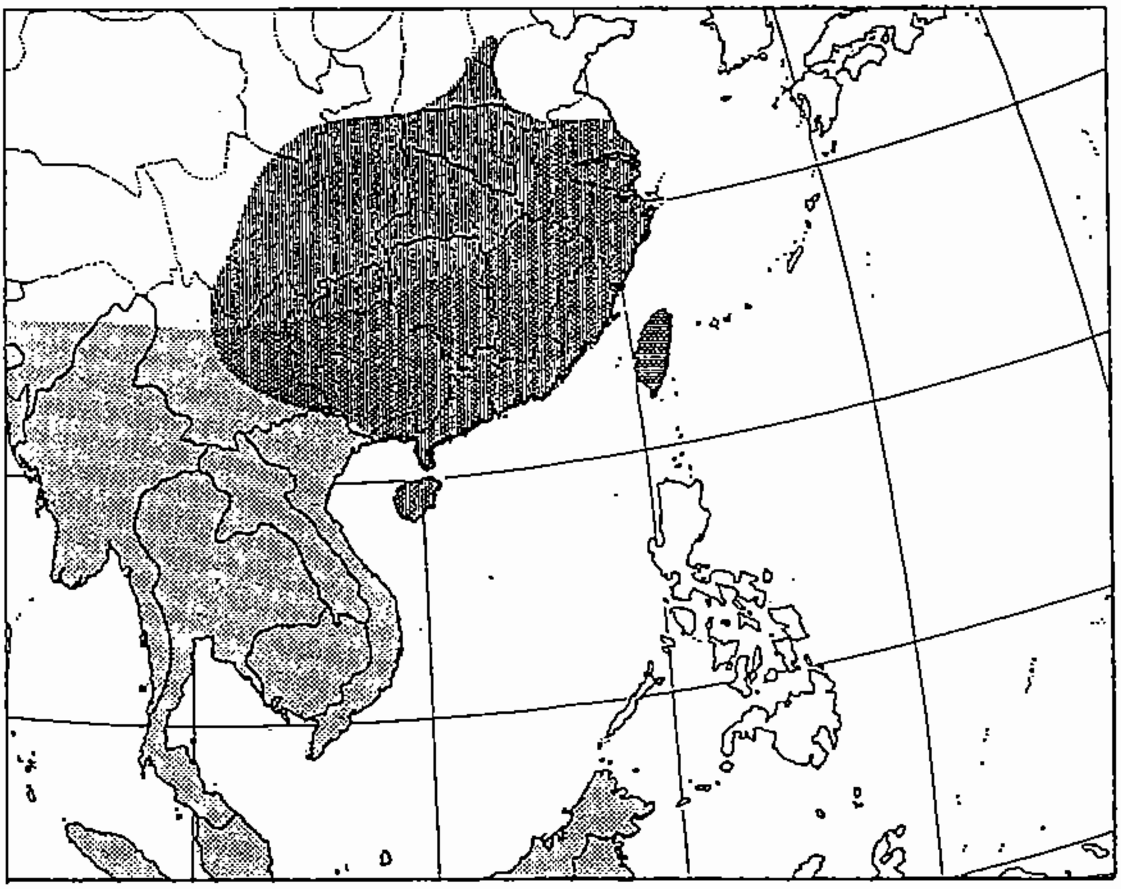


Fig. 35. A map of East and Southeast Asia showing ranges of *Xenochrophis piscator* (stippled area), and *Zaocys dhumnades Oshimai* (horizontally hatched area) and the other subspecies (vertically hatched area).

Genus *Zaocys* Cope, 1861

Distribution.--South, Southeast and East Asia.

Remarks.--Welch (1988) treated the genus as a synonym of *Ptyas* but without providing any explanations.

Zaocys dhumnades (Cantor, 1842)

Distribution.--The main-island. Known also from the eastern and the southeastern continental China (Fig. 35).

Zaocys dhumnades oshimai Stejneger, 1952

Distribution.--Confined to the main-island.

Remarks.--Mao(1965b) verified the validity of *Z. d. oshimai* as an endemic subspecies of Taiwan.

Family Elapidae Boie, 1827

Genus *Bungarus* Daudin, 1803

Distribution.--South, Southeast and East Asia.

Bungarus multicinctus Blyth, 1860

Distribution.--The northern Indochina, and the southern and the southeastern China.

Bungarus multicinctus multicinctus Blyth, 1860

Distribution.--The main-island. Known also from the southeastern continental China (Fig. 36).

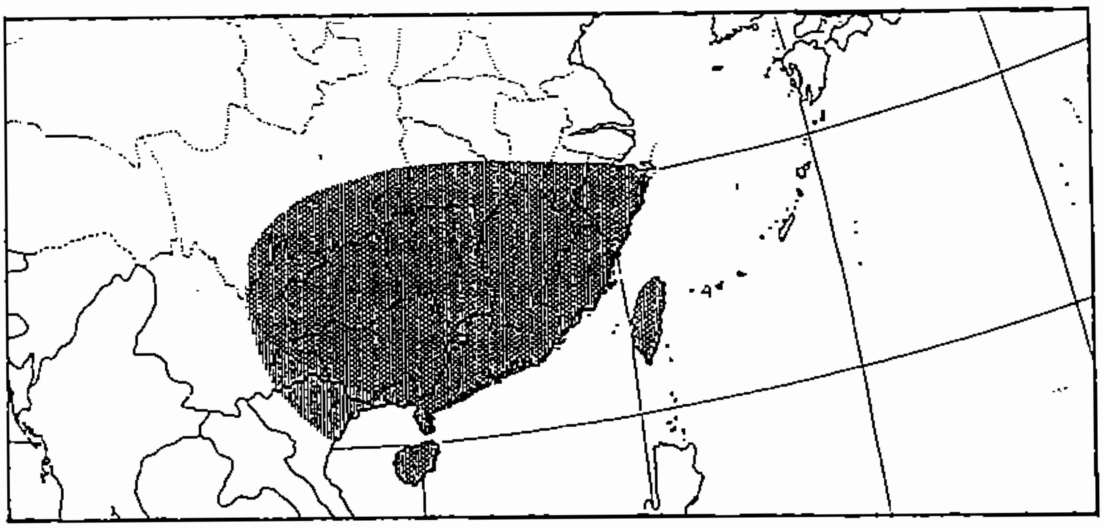


Fig. 36. A map of East and Southeast Asia showing ranges of *Bungarum multicinctus multicinctus* (stippled area) and *Naja naja atra* (vertically hatched area).

Genus *Naja* Laurent, 1768

Distribution.--Tropical and subtropical Asia and Africa.

Naja naja (Linnaeus, 1758)

Distribution.--Widely distributed in Southwest, South, Southeast and East Asia.

Naja naja atra Cantor, 1842

Distribution.--The main-island. Known also from the northern Indochina and the southeastern continental China (Fig. 36).

Genus *Calliophis* Gray, 1834

Distribution.--South, Southeast and East Asia.

Remarks.--Smith (1943) negated the distinctiveness between *Hemibungarus* Peters, 1862 (type species: *Elaps calligaster* Wiegmann, 1834) and *Calliophis* (type species: *Calliophis gracilis* Gray, 1834), and synonymized the former with the latter. McDowell (1986) demonstrated the high heterogeneity of *Calliophis* [*sensu* Smith (1943)] on the basis of jaw architecture and other morphological characters: he revealed the distinct differences especially between *C. gracilis* and a subgroup consisting of *calligaster*, *japonicus*, *macclellandi* and *kelloggi*. Later, he (1987) used *Hemibungarus* as the generic name for *calligaster*, but retained the latter three species in *Calliophis*. Morphological features described by McDowell (1986, 1987) seem to be sufficient for the removal of *japonicus*, *macclellandi* and *kelloggi* from *Calliophis* to reassign them to *Hemibungarus*. I, however, follow McDowell (1987), and defer the problem for future, inclusive studies on the genus *Calliophis* (*sensu lato*).

Calliophis macclellandi (Reinhardt, 1844)

Distribution.--Nepal, northern India, northern Indochina, southern, southeastern and eastern China, and the southern Ryukyus (Fig. 37).

Remarks.--Three subspecies are recognized.

Calliophis macclellandi swinhoei Van Denburgh, 1912

Distribution.--Endemic to the main-island.

Calliophis japonicus Günther, 1868

Distribution.--The main-island. Known also from the central Ryukyus (Fig. 38).

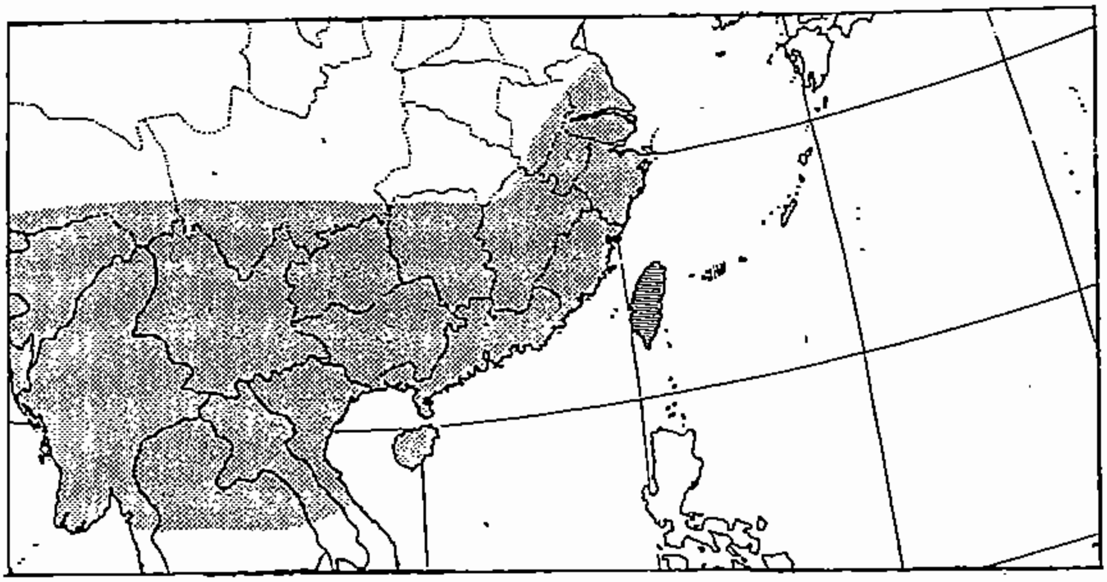


Fig. 37. A map of East and Southeast Asia showing the range of *Calliophis macclellandi swinhoei* (horizontally hatched area). Ranges of the nominotypical subspecies and *C. m. iwasakii* are also indicated with stipples and vertical hatches, respectively.

Remarks.--Loveridge (1946) treated *sauteri* as a subspecies of *Calliophis japonicus*, and most subsequent authors referring to the classification of the East Asian *Calliophis* have tentatively followed this account (e. g., Nakamura and Uéno, 1963; Koba et al., 1977). Distributional pattern of the subspecies (Fig. 38), however, seems to imply that future detailed studies will separate the Taiwanese from the Ryukyu populations as a full species. Character distributions of *Calliophis* species provided by McDowell (1986, 1987) seem to indicate that *C. japonicus* is most closely related to *C. kellogi* from the continent.

Calliophis japonicus sauteri (Steindachner, 1913)

Distribution.--Endemic to the main-island.

Family Viperidae Laurenti, 1768

Genus *Ovophis* Burger in Hoge et Romano-Hoge, 1981

Distribution.--South, Southeast and East Asia.

Remarks.--Burger (1971), in his Ph. D. dissertation, recognized a natural group consisting of *monticola* and a few other terrestrial forms in the genus *Trimeresurus* to form a new genus, *Ovophis*. However, this important work was not published. Later, Hoge and Romano-Hoge (1981) repeated Burger's (1971) definition of *Ovophis* in their publication. Smith (1989), therefore, confirmed the authorship of the genus as above. Although there still remain some problems in the monophyly of *Ovophis* [see Groombridge (1986) for example], I tentatively treat here as valid.

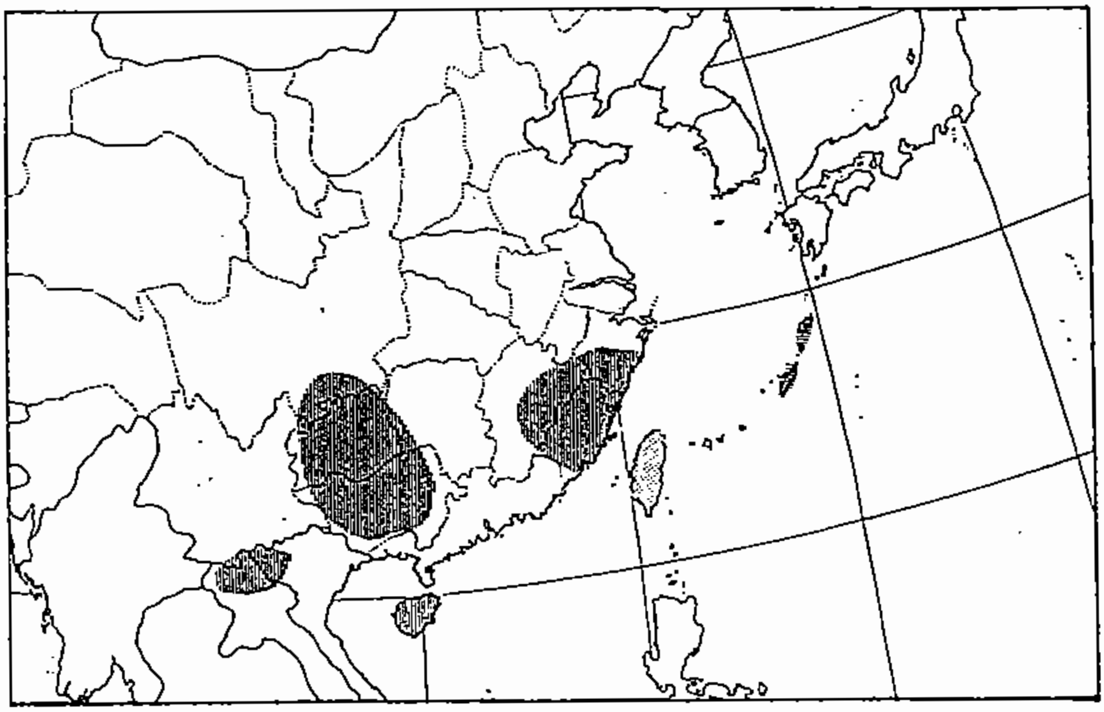


Fig. 38. A map of East and Southeast Asia showing the range of *Calliophis japonicus sauteri* (stippled area). Ranges of the other subspecies of *C. japonicus* and *C. kellogi*, the possible closest relative of the former, are also indicated with horizontal, and vertical hatches, respectively.

Ovophis monticola (Günther, 1864)

Distribution.--South, Southeast and East Asia.

Ovophis monticola makazayazaya (Takahashi, 1922)

Distribution.--Endemic to the high altitudes of the main-island (Fig. 39).

Remarks.--Most closely resembling *O. m. orientalis* from the eastern continental China.

Genus *Trimeresurus* Lacepede, 1804

Distribution.--South, Southeast and East Asia.

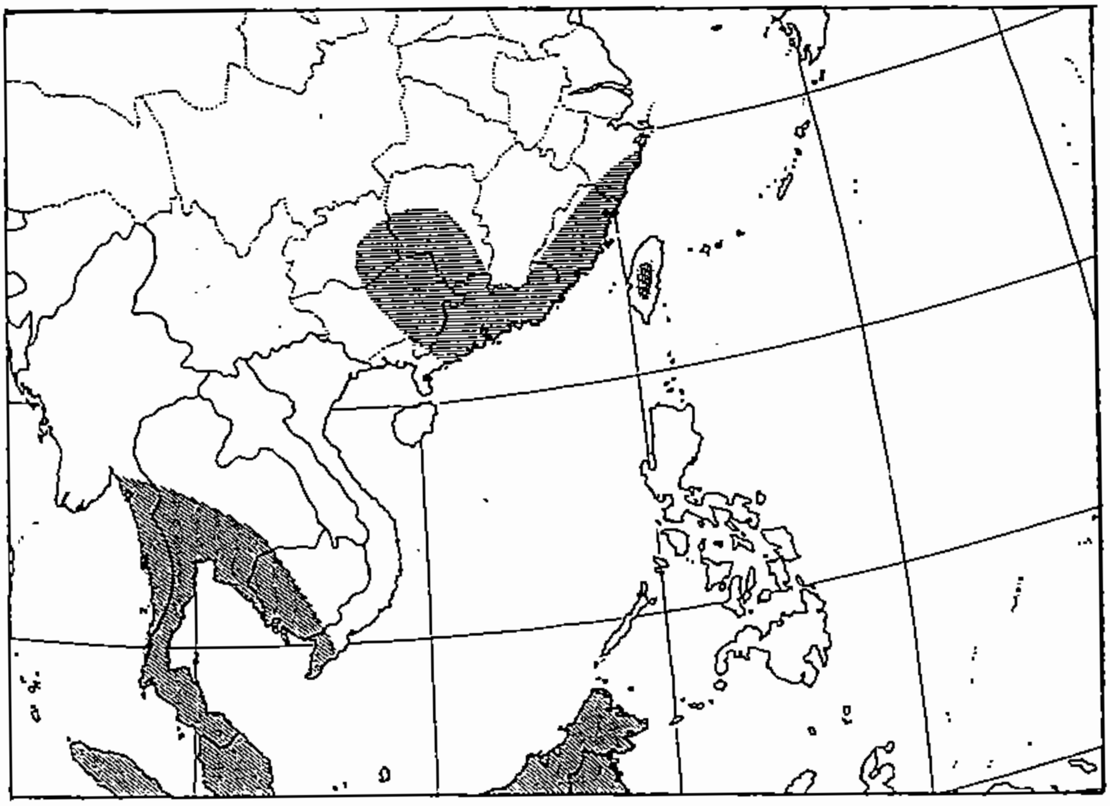


Fig. 39. A map of East and Southeast Asia showing ranges of *Ovophis monticola makazayazaya* (stippled area) and *Trimeresurus gracilis* (vertically hatched area). Ranges of *O. m. orientalis*, and *T. borneensis* and *T. puniceus*, the possible closest relatives of the latter, are also indicated with horizontal and oblique hatches, respectively.

Trimeresurus gracilis Oshima, 1920

Distribution.--Endemic to the high altitudes of the main-island (Fig. 39).

Remarks.--Brattstrom (1964) tentatively assumed this species to be most closely related to *T. borneensis* and *T. puniceus* on the basis of external characteristics.

Trimeresurus stejnegeri Schmidt, 1925

Distribution.--Northern India, northern Indochina, and the southern and the southeastern China.

Remarks.--Chinese populations have often been confused with *T. gramineus*, which range, however, is confined to South and Southeast

Asia in reality (Pope and Pope, 1933; Hoge and Romano-Hoge, 1981; Welch, 1988). Maki (1931) recognized three subspecies within Taiwan, but Pope (1935) and Mao (1962) assumed them as color variants without any taxonomic significances.

Trimeresurus stejnegeri stejnegeri Schmidt, 1925

Distribution.--The main-island and Lanyu Island. Known also from the southeastern continental China (Fig. 40).

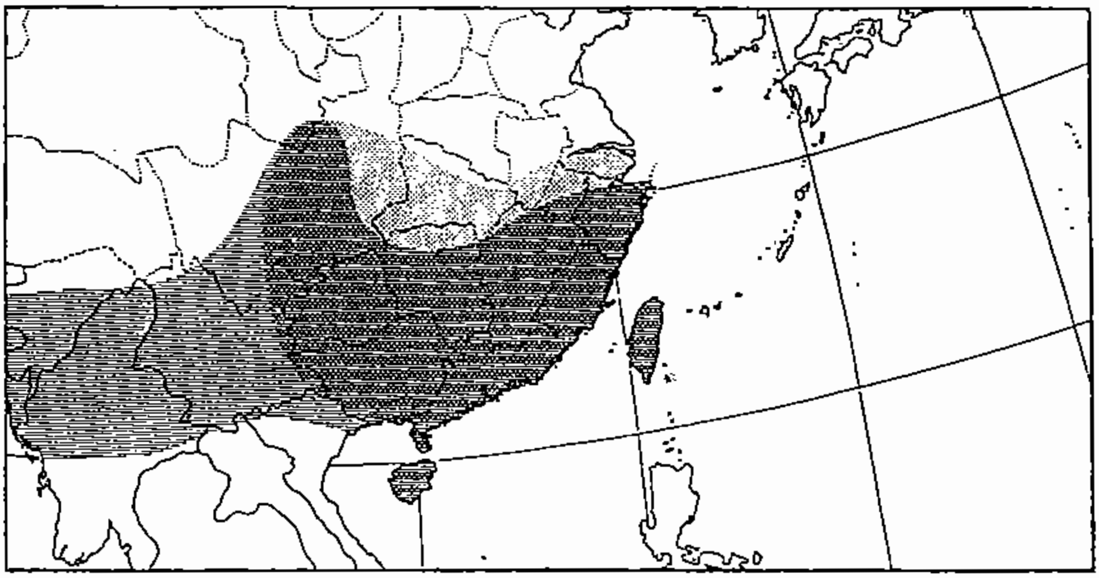


Fig. 40. A map of East and Southeast Asis showing ranges of *Trimeresurus stejnegeri stejnegeri* (stippled area) and *T. mucrosquamatus* (horizontally hatched area).

Trimeresurus mucrosquamatus (Cantor, 1839)

Distribution.--The main-island. Known also from the northern India, northern Indochina, and the southern and the southeastern continental China (Fig. 40).

Remarks.--Hoge and Romano-Hoge (1983) established a new genus *Protobothrops* (type species: *flavoviridis* from the central Ryukyus) chiefly on the basis of external microstructures to accommodate three species including *mucrosquamatus*. However, as is pointed out by Toriba (1989), there is no other supports for the monophyly of this group. Thus, I do not use *Protobothrops* as valid here.

Genus *Dienagkistrodon* Gloyd, 1979

Distribution.--Represented by the range of *acutus* below.

Remarks.--Gloyd (1979) described *Dienagkistrodon* as a monotypic genus.

Dienagkistrodon acutus (Günther, 1888)

Distribution.--The main-island. Known also from the northern Indochina and the southeastern continental China (Fig. 41).

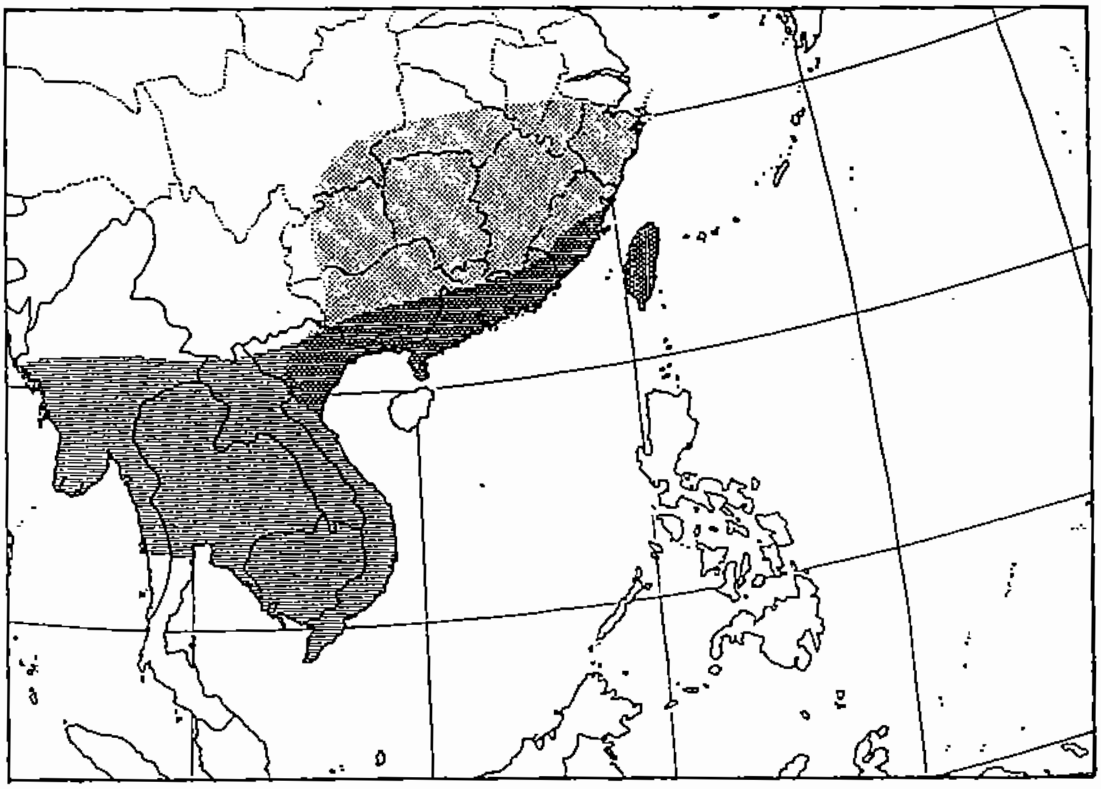


Fig. 41. A map of East and Southeast Asia showing ranges of *Dienagkistrodon acutus* (stippled area) and *Vipera russellii formosensis* (vertically hatched area). The range of *V. r. siamensis* is also indicated with horizontal hatches.

Genus *Vipera* Laurent, 1768

Distribution.--Eurasia.

Vipera russellii (Shaw, 1797)

Distribution.--South, Southeast and East Asia.

Vipera russellii formosensis Maki, 1931

Distribution.--Endemic to the main-island (Fig. 41).

Remarks.--Closely resembling *V. r. siamensis* from Indochina and the southeastern continental China.

Family Emydidae Gray, 1825

Genus *Chinemys* Smith, 1931

Distribution.--Northern Indochina, and southern and eastern China.

Remarks.--Smith (1931) partitioned the genus *Geoclemys*, and established *Chinemys* with *reevesii* as the type species.

Chinemys reevesii (Gray, 1831)

Distribution.--The main-island. Known also from the eastern continental China, Korea and the main-islands of Japan (Fig. 42).

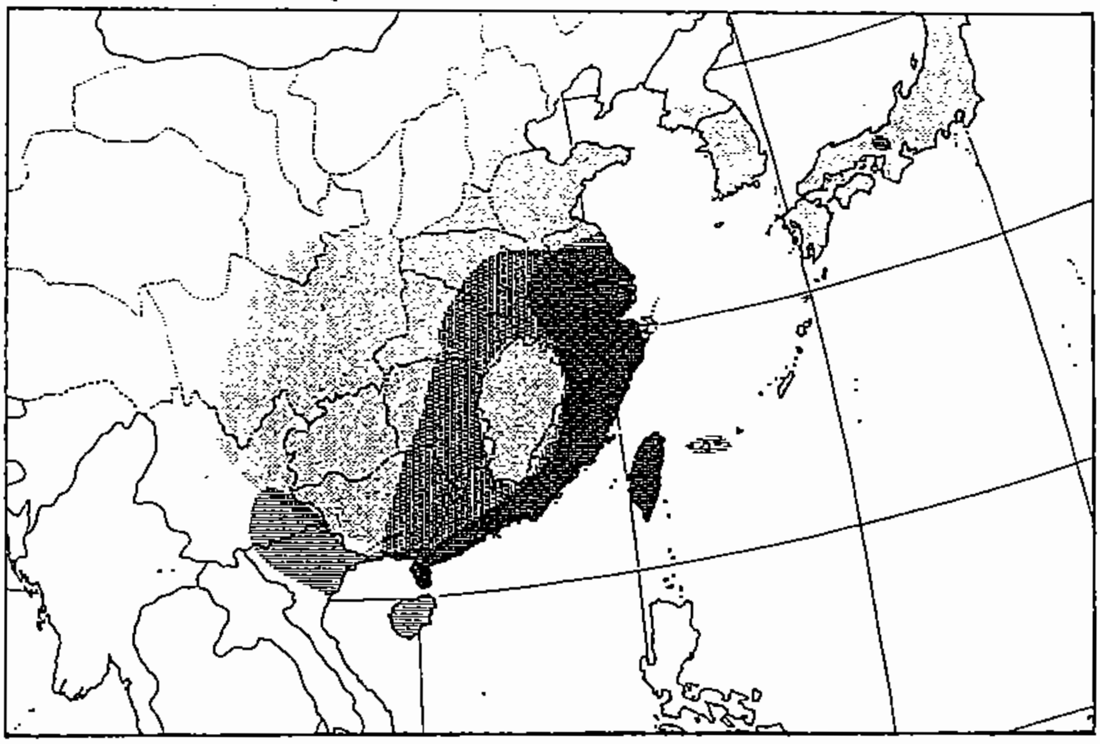


Fig. 42. A map of East and Southeast Asia showing ranges of *Chinemys reevesii* (stippled area), *Cistoclemmys flavomarginata* (vertically hatched area) and *Mauremys mutica* (horizontally hatched area).

Remarks.--Lovich et al. (1985) noted on a color variety possibly confined to Taiwan but on the basis of a small sample. They also pointed out the similarity between samples from Taiwan and the southeastern continental China, which may possibly be interpreted as indicative of the past entry of this turtle from the latter to the former regions. Although Lovich et al. (1985) assumed the dispersal by means of rafting on the Kuroshio Current, it seems more likely that *C. reevesii* entered into Taiwan through the recent land-bridge connecting Taiwan to the continent (see BIOGEOGRAPHY section below for further discussion.).

Genus *Cistoclemmys* Gray, 1863

Distribution.--Southeast and East Asia.

Remarks.--Hirayama (1984) recognized two subgroups within the genus *Cuora* Gray, 1855, on the basis of cladistic analysis of osteological characters. He thus resurrected *Cistoclemmys* to accommodate three species including *flavomarginata*. However, evaluation of the status of *Cistoclemmys* is still in dispute [e.g., validated by Gaffney and Meylan (1987), but invalidated by Sites et al. (1984)], and requires future verifications.

Cistoclemmys flavomarginata Gray, 1863

Distribution.--The main-island. Known also from the southeastern continental China (Fig. 42).

Remarks.--Ernst and Lovich (1990) compared samples from Taiwan and the continent morphologically in detail, and found no differences between them.

Genus *Mauremys* Gray 1870

Distribution.--Mediterranean coasts of Africa and Europe, Middle East, and Southeast and East Asia.

Remarks.--McDowell (1964) partitioned the genus *Clemmys* Ritgen, 1828, and resurrected *Mauremys* to accommodate a few species including *mutica*.

Mauremys mutica (Cantor, 1842)

Distribution.--The main-island. Known also from the northern Indochina, the southern continental china, the southern and the northern Ryukyus, and Kyoto, Japan (Fig. 42).

Remarks.--The specific name *mutica* Cantor, 1842, having usually been used for Taiwanese and Japanese populations (e.g., Mao, 1971; Nakamura and Uéno, 1963; Wang and Wang, 1956), is often regarded as a junior synonym of *nigricans* Gray, 1834 (e.g., Wermuth and Mertens, 1977; Iverson, 1986). However, Iverson and McCord (1989) demonstrated its validity on the basis of large samples.

Genus *Ocadia* Gray, 1870

Distribution.--Represented by the range of *sinensis* below.

Ocadia sinensis (Gray, 1834)

Distribution.--The main-island. Known also from northeastern Indochina, and the southeastern and the eastern continental China (Fig. 43).

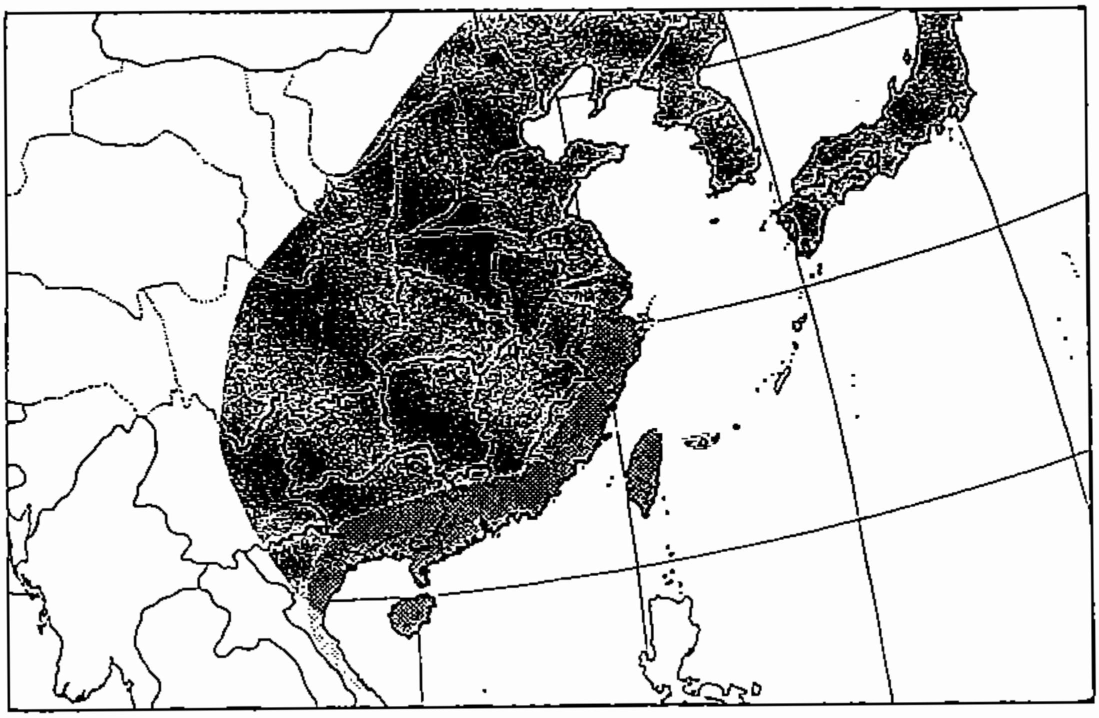


Fig. 43. A map of East and southeast Asia showing ranges of *Ocadia sinensis* (stippled area) and *Pelodiscus sinensis* (horizontally hatched area).

Family Trionychidae Bell, 1828

Genus *Pelodiscus* Gray, 1844

Distribution.--Represented by the range of *sinensis* below.

Remarks.--Based on the cladistic analysis using osteological characters, Meylan (1987) partitioned the genus *Trionyx* (*sensu lato*), and resurrected *Pelodiscus* as a monotypic genus to accommodate *sinensis*.

Pelodiscus sinensis (Wiegmann, 1835)

Distribution.--The main-island. Widely distributed in the northern Indochina, the southeastern and the eastern continental China, Korea and Japan (Fig. 43).

Doubtful and/or Unconfirmed Records

The following species are listed in Wang and Wang (1956) and/or other recent publications as occurring in Taiwan. I, however, suspect that their records from this region actually derived from specimens with wrong locality labels or misidentifications, or based on artificially introduced transient colonies. As such, I excluded these species from the biogeographical analyses in the next section.

Gekko gecko (Linnaeus, 1758)

Remarks.--See Ota (1989d).

Cosymbotus platyurus (Schneider, 1792)

Remarks.--See Ota and Hikida (1985).

Eumeces barbouri

Remarks.--See Hikida (1989).

Eumeces marginatus

Remarks.--See Hikida (1989).

Lamprolepis smaragdina (Lesson, 1830)

Remarks.--Stejneger (1910) recorded this species from the central montane region of Taiwan on the basis of one juvenile brought by Owston's collector and received through Barbour. But the second specimen has not ever been obtained. Lin and Cheng (1990), therefore, tentatively assumed the recent extinction of the Taiwanese population of this lizard. However, considering the high prosperity of this lizard around its range and especially in open environments of artificially disturbed and/or coastal regions (Brown and Alcala, 1980; Ota, private observations), it seems more likely to me that the Stejneger's (1910) specimen bore a wrong locality record in reality. Absences of this species on Lanyu and Lutao Islands, as well as the continent, offer circumstantial supports for this assumption.

Enhydris bennettii (Gray, 1842)

Remarks.--Maki (1931) tentatively listed this species as occurring in Taiwan on the basis of a single specimen deposited in Indian Museum. However, the absence of a second record strongly suggests the probability that the specimen was incorrectly catalogued.

Hurria rynchops (Schneider 1799)

Remarks.--The situation is similar to that of *L. smaragdina* mentioned above.

BIOGEOGRAPHY

In the above section, I listed all reptilian taxa recognized from Taiwan, and outlined the range of the presumable closest relative for each taxon from outside (extra-Taiwanese populations for widely distributed species, conspecific(s) for endemic subspecies, and the presumable closest congener for endemic species) as long as some inferences for relationships are possible. Using this data set, I attempt to make preliminary biogeographical analyses of the Taiwanese reptiles.

Of the 80 species and subspecies listed above, three (*Lepidodactylus lugubris*, *Hemiphyllodactylus typus typus*, and *Varanus salvator*) are regarded as presumably nonnative elements that were introduced to Taiwan artificially (Ota, 1986; Ota and Ross, 1990; Lin and Cheng, 1990). I, as such, exclude them, as well as *Eumeces chinensis leucostictus* endemic to Lutao Island, from the following analyses, and consider the remaining 76 species and subspecies only. Also, since several previous studies have claimed for the faunal distinctiveness between the main-island and Lanyu Island (e.g., Kano, 1935a, b; 1936a-e), I treat the two regions separately in the similarity analysis of reptilian fauna as below.

General similarity in fauna.--In this subsection, I discuss the general faunal similarities of the main-island and Lanyu Island with each other, as well as with other adjacent regions (i.e., the continental China, the Philippines, and the Ryukyu Archipelago). Such a comparison might have a substantial problem as an approach to the historical relationships among areas involved (see the next section). However, since it has already been attempted by several authors (e.g., Wang and Wang, 1956; Wang, 1962; Lue et al., 1988), presentation of corresponding data using the most recent information is useful to evaluate the previous assumptions to some extent, I believe.

To estimate the faunal similarity, I calculate Nomura-Simpson's index:

$$\frac{\text{The number of shared species and subspecies}}{\text{The total species and subspecies number in one of the two compared areas with poorer fauna}} \times 100\ (\%)$$

for each combination of localities.

Of the 76 possibly native species and subspecies recognized from Taiwan, 73 and 17 are distributed in the main-island and Lanyu Island, respectively. The two islands share 14 species and subspecies, and thus, the index equals 82.4. The main-island shares 42, 6, and 11 species and subspecies with the continent [the total number of species and subspecies (TSN) > 76), the Philippines (TSN > 76) , and the Ryukyu Archipelago (TSN = 49), and indices are thus calculated as 57.5, 8.2 and 22.4, respectively. On the other hand, Lanyu Island shares 11, 5, and 6 species and subspecies with the continent, the Philippines, and the Ryukyu Archipelago, respectively. Therefore, the indices equal 64.7, 29.4, and 35.3, respectively. The numbers of species and subspecies endemic to the main-island, Lanyu Island, and the combined area are 27, 2, and 31, respectively.

The results indicate the close faunal resemblance between the main-island and Lanyu Island. The fauna of the former is also somewhat similar to that of the continent, and then to that of the Ryukyus, and is most differentiated from the Philippine fauna. Likewise, the fauna of Lanyu Island is much similar to that of the continent, and then of the Ryukyus, whereas it shows relatively little similarity with the Philippine fauna. Patterns of similarities largely coincide with those indicated in Wang and Wang (1956), Wang (1962), Lue et al. (1988), etc., and is essentially different from that assumed by those who argued the close faunal similarity between Lanyu Island and the Philippines (e.g., Kano, 1935a, b; 1936a-e).

Analysis of distributional patterns of endemic taxa and their relatives.--The comparison by use of the similarity indeces is a conventional method repeatedly adopted in the biogeographical studies of the East Asian reptiles. This generalization, however, blocks the progress of more detailed analyses by ignoring the differences between the common occurrences of widely distributed taxa and of those confined to the two regions in problem. Moreover, this approach usually pays little attention to endemic taxa, which would actually bear much on the geohistory of areas where they occur. For instance, if the fauna of a given geographic unit "A" wholly consists of endemic elements, its similarity indecies with units "B" and "C" would equally be zero. But if all elements endemic to "A" have phylogenetically closest relatives exclusively in "B", it would easily be interpreted as indicative of closer historical relationship of "A" with "B" than with "C". The most important theoretical presumption to warrant this approach is the coincidence between the relative lengths of disjunction periods among areas and the relative evolutionary distances among organisms forming a monophyletic group and isolated from each other on these areas. This is generally supported from the paradigm of cladogenesis associated with the allopatric speciation model. This so-called vicariance view has recently been adopted for the biogeographical analyses especially of Neotropical regions (e.g., Nelson and Rosen, 1981; Rosen, 1975, 1978).

Operationally, the reliability of the results provided by the analysis of this kind depends on those of the inferred phylogenetic relationships among organisms from areas in problem. In this regard, it is currently difficult to apply this approach to the present materials, because very few of the East Asian reptiles have yet been analysed phylogenetically by scientifically appropriate methods, i.e., on the basis of more than a general similarity. Even so, however, it is not meaningless to discuss the herpetogeography of Taiwan by taking the vicariance view point into considerations and by making best of the currently available information, I believe. Because it will clarify, at least, what should be done for the next step.

Based on distributional patterns of possible closest relatives outside Taiwan, I have classified the Taiwanese endemic taxa into five groups as follows.

Group A: Characterized by the occurrence of the closest relatives in the Ryukyu Archipelago. Accommodating *Japalura swinhonis, J. brevipes, J. makii, J. polygonata* subsp. (Fig. 1), and *Achalinus formosanus formosanus*.

Group B: Characterized by the occurrence of the closest relatives in the Philippines. Accommodating *Gekko kikuchii* (Fig. 4) and *Lepidodactylus yami* (Fig. 7).

Group C: Characterized by the occurrence of the closest relatives in Fukien Province of China, the eastern coast of the continent neighboring Taiwan. Accommodating *Takydromus stejnegeri, T. formosanus* (Fig. 10), *Scincella formosensis* (Fig. 16), ?*Ophisaurus formosensis* (Fig. 18), *Amphiesma miyajimae* (Fig. 21), *Elaphe mandarina takasago* (Fig. 25), *Elaphe taeniura friesei* (Fig. 26), *Pseudoxenodon stejnegeri stejnegeri* (Fig. 30), *Rhabdophis tigrinus formosanus* (Fig. 32), *Sinonatrix percarinata suriki* (Fig. 34), *Zaocys dhumnades oshimai* (Fig. 35),?*Calliophis maccellandi swinhoei* (Fig. 37), ?*C. japonicus* *sauteri* (Fig. 38), *Ovophis monticola makazayazaya* (Fig. 39) and *Vipera russellii formosensis* (Fig. 41).

Group D: Characterized by the occurrence of the closest relatives in the continent but not in Fukien Province. Accommodating *Takydromus hsuehshanensis* (Fig. 12), ?*Sphenomorphus taiwanensis and Trimeresurus gracilis* (Fig. 39).

Group E: Relationships wholly unknown. Accommodating *Takydromus sauteri, Typhlops koshunnensis, Achalinus niger, Pareas formosensis, P. komaii*, and *Rhabdophis swinhonis*.

The numerical dominace of endemic taxa belonging to Groups C and D confirms the closest geohistorical relationship between Taiwan and the continent, that were suggested by the analysis using similarity index above. Also, this coincides with the geological and geomorphological features of the east Chinese region, which suggest that Taiwan was directly connected to the continent by the land-bridge throughout the Pleistocene, and was only recently isolated by the submergence of the bridge caused by the reduction of the latest (Würm) glacier (less than 20,000 years ago: Kizaki and Oshiro, 1977, 1980). However, the apparent absence of the closest relatives of the Group D species in the eastern coast of the continent seems to indicate their more ancient dispersal and isolation in Taiwan than those of the species and subspecies belonging to the Group C. It is interesting to note that the occurrences of all members of the Group D are confined to the high altitudes of the main-island. I suspect that these species had already been isolated from their relatives before the latest glacier to be relict elements (Darlilngton, 1957).

The four *Japalura* belonging to the Group A, as well as *J. polygonata* from the Ryukyu Archipelago, much resemble each other against the other congeners (Ota, 1989b; Ota, 1991c), and hence, may presumably be monophyletic. This and the absence of congeneric species in the adjacent areas (Fig. 1) suggest the relatively ancient entry of their common ancestor into this region. Furthermore, the presence of the congeneric species in the inland area of the continent and their absence in the mainland of Japan or Korea suggest its entry from the continent.

Both of the two gekkonids of the Group B are endemic to Lanyu Island, and may seem to indicate its close relationship with the Philippines as was argued by Kano (1935a, b, 1936a-e). He, after analysing distributional patterns of various organisms in the Philippines, Lanyu Island, and the main-island, postulated the presence of a land-bridge connecting Lanyu Island and the

Philippines during the late Pliocene or early Pleistocene. However, the close similarities of the two species with their Philippine counterparts (Ota and Crombie, 1989; Ota, unpublished data) seem to suggest their more recent entries and isolations, although the recent formation of land-bridge seems unlikely (Dickerson, 1924). Leviton (1963b) surmised the dispersal of some reptiles from Luzon Island northward by rafting, and pointed out the presence of a favorable current in this area. This explanation may be applied to the occurrences of *Gekko kikuchii* and *Lepidodactylus yami*, as well as of *Mabuya multicarinata borealis* (see Ota, 1991d), on Lanyu Island.

Again, the largest logical problem in the above hypothesis lies in its supposing the general similarity as the phylogenetic affinity. Because, although they may usually correlate with each other, there may also be some cases in which similarity has arisen merely from parallel derivation or convergence [see Wiley (1981) for numerous examples]. Thus, the inference of phylogenetic relationships by means of appropriate methods are strongly desired for the further advances of biogeography, as well as systematics, of reptiles in Taiwan.

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BIRD CONSERVATION OF JAPAN

市田則孝

Noritaka Ichida

Wild Bird Society of Japan

This is a report to introduce a brief history of bird conservation system and efforts of Japan. The NGO's efforts for the bird conservation introduced here are mainly done by the Wild Bird Society of Japan, one of the biggest conservation society of the country.

A. Legal Regulation for Bird Conservation

It was 1895 when the first law for the protection of birds went into force in Japan. The law was called as "The Hunting Law" and the government became to be able to designate a protected bird species by the law. Before that hunters could shoot all bird species. So this law is the first effort to protect birds of Japan but the number of the protected bird species was limited. Only ten species such as the crane, swallow and great tit were designated.

In 1918, a big amendment of the law was made and all the bird species were basically protected by the amended law. The 187 species were listed as game birds. This is a basic change of the idea of the bird protection of Japan. Before this amendment, the government protected only some important species but through this amendment, basically all the species were protected although many number of the bird species were still listed as game birds.

In 1963, the name of the law was changed from the Hunting Law to The Bird Protection and Hunting Law and many amendments were made at the same time for the promotion of the bird protection.

In 1989, the Bird and animal Protection Division of the Environment Agency, the central government, was reorganized as Wildlife Protection Division to protect not only birds and mammals but all wildlife. Now a big amendment is under the preparation and name of the law will be changed again to The Wildlife Protection Law.

B. Change of the People's Understanding of the Bird Conservation

In 1930's, the people's understanding of the bird conservation was very poor and the imagination of the word "Bird" was a caged bird or bird to eat. So Mr. G. Nakanishi established the Wild Bird Society of Japan (WBSJ) for the promotion of the bird conservation creating new Japanese words "Wild Bird" and "Birdwatching Trip" in 1934.

But only small number of the people was interested in those activities and the membership of the society was limited to 2000 for many years. In 1970, a big wave of the nature conservation came from the United States and people of Japan began to understand the importance of bird conservation and environment protection. It was regrettable for the Environment NGO's of Japan that they were so busy to point out the conservation problems and could not show any solutions to the government or the public then could not show any solutions to the government or the public then could not attract as many people as US NGO's did. People's understanding of the conservation groups was poor and the telephone number of the WBSJ was listed at the corner of the pet shops in the telephone directory.

In 1985, Japan Broadcasting company (Nihon Hoso Kyokai: NHK) started a new TV program titled "Watching". This is a program to introduce the ecology or ethology of Japanese wildlife in a very attractive way and it became so popular as a wildlife TV program. The success brought an advantage for the conservation bodies to get new members as many people were interested in wildlife. Membership of WBSJ, for example, became 2,500 in 1970 to 32,000 in 1990. The membership of the similar organizations is also increasing and this increase will show the promotion of the understanding of the conservation of the people.

C. Bird Conservation Problems

C-1 Habitat Protection

The most important thing for the protection of birds of Japan is to protect the habitats of birds. The hunting pressure is also a problem but not so much compared with the habitat destruction.

By The Bird Protection and Hunting Law, the government can designate important areas as wildlife protection areas. Until 1989, the government designated 3,997 areas (3,507,000 ha) as the wildlife protection area. But the wildlife protection area is only 9.45 percent of the country and the hunting is not prohibited in the most of other areas.

The function of the wildlife protection area is actually non-hunting area and the development which means destruction of the habitat for birds is controlled only in the special protection area. The special protection area designated is only 606 places, 321,000 ha. This is 0.6 percent of the country.

The government has been working to increase the number and the acreage of the wildlife protection area. Thus the number of the area increased from 2,370 places (1,797,050 ha) to 3,997 places (3,507,000 ha). But the conservation bodies requesting the government to change the basic idea of the protection area. They insist to prohibit hunting all through the country and designate some hunting areas for the hunters and all the developments should be controlled inside of the wildlife protection area.

In 1977, WBSJ started their Bird Sanctuary Campaign saying "Now is the time to establish the first bird sanctuary in Japan". The aim of this campaign is to establish an ideal wildlife protection area to show how the wildlife protection area should be. The meaning of the sanctuary was explained as follows.

1. The place for wildlife.
2. Any development should be prohibited inside of the place.
3. The place should be managed by an experienced ranger.
4. Environment education program will be carried by the ranger.

In addition to the habitat protection, the importance of the management of the area was emphasized because there is almost no management for the wildlife protection areas of the government. Official rangers are working only for the National Parks.

The first bird sanctuary of the society was established at the Lake Utonai, Hokkaido by the donation of 100 million Yen from the members and the public in 1981. This campaign showed a good sample of the wildlife conservation area and created positive imagination of the conservation movement. Many government officers are interested in the Lake Utonai Bird Sanctuary and Mr. Kawarada, the Mayor of the Fukushima City decidee to establish one with the technical assistance of WBSJ and opened it in 1983. This is the first sanctuary on the government level and several ones were established following the Fukushima City.

In 1984, The Environment Agency started the Urban Sanctuary Project in co-operation with the local government. And the first one was established at a hillside of Yokohama city, near Tokyo.

Now the network of the bird sanctuary was expanded through the country and expected to tie similar ones of foreign countries. so the plan to establish a bird sanctuary at Kuwan Tsu near Taipei will be a key to make a network of the sanctuary along the migration route of the birds of Asia.

C-2 Habitat Improvement

In addition to the habitat protection, it is necessary to promote the habitat improvement to save the birds. There is a good example in the reclaimed land of Tokyo bay where the most of the natural tidal flat was destroyed already.

Tokyo Metropolitan Government established a waterbird sanctuary in the reclaimed land of the bay. The name of the sanctuary is Tokyo Bay Bird Park and three ponds were made with freshwater, blakishwater and sea-water to attract birds and a trial to make a breeding colony of the Little tern, Sterna albifrons, on the roof of the nature center of the sanctuary was started in 1990.

C-3 Species Protection

Among 555 species of birds recorded in Japan, 8 species and 19 subspecies are listed as the Endangered Species by the government.

The captive breeding of the following species is successful but the re-introduction of the birds is not yet started. The difficulty of the re-introduction program is to reserve a good habitat for these birds.

1. Japanese Crane *Grus Japonensis*
2. White Stork *Ciconia ciconia boyciana*

And the protection measurements are discussed to protect the following species in particular and several projects were started already.

1. Japanese Crested Ibis, *Nipponia nippon*

Only two individuals are surviving and captive breeding is not successful yet. but the similar trial in Beijing Zoo is successful.

2. Short-tailed Albatross, *Diomedea albatrus*

This bird breeds on Torishima island which is 600 km south of Tokyo and because of the habitat improvement of the breeding site planting *Miscanthus sinensis*, the population in increasing up to 500.

But in the recent years, the erosion of the breeding site became serious and it destroyed the vegetation which is important for the successful breeding of the bird. So the trial to move the breeding population to the other side of the island has been discussed.

3. Blakiston's Fish-Owl, *Ketupa blakistoni*

This large Owl distributes only in the eastern Hokkaido and the estimated wild population is some 60. The government started nest box Program and feeding. Both program seems successful but the captive breeding is not yet succeed.

4. Okinawa Woodpecker, *Sapheopipo noguchii*

This woodpecker occurs only in the forest of the northern part of ain island of Okinawa. The estimation of the population is only 100 in total. The most important action to save this bird is to protect the forest of the area, but most of the area is not yet designated as a wildlife protection area and the logging is serious in this area. Prompt action to protect the forest and the woodpecker is needed.

D. Conservation Education

D-1 Birdwatching Trip

To organize a chance for the public to enjoy the birs in the field is very important to let them understand the importance of the bird conservation. At the WBSJ, 72 chapters have been organizing birdwatching trips on the weekend and this is a very good event to let the people enjoy the birds and wildlife in the field and understand the meaning and importance of conservation.

In 1990, chapters of WBSJ held birdwatching trip 2,500 times and 70,000 people attended the trip and enjoyed the birds in the field. Most of the other conservation groups have also been organizing the similar trip to promote the understanding of their movement and this is a good opportunity for them to get a new member.

D-2 Publication of Field Guide

A field guide to the birds of each area is essential for enjoying birds in the field. WBSJ published a new complete field guide to the birds of Japan and this contributed so much to promote the birdwatching activities in Japan. The handy booklet of mountain birds and waterbirds are good sellers and WBSJ has been selling over 30,000 copies of those booklet every year. This means over 30,000 people enjoyed birding every year.

The co-operative work to publish a field guide to the birds of Taiwan between the Taiwan Wildbird Information Center and WBSJ is successful and the guide will be published soon.

E. Research for Conservation

E-1 Waterfowl Count

The waterfowl count has been done by the Environment Agency since 1970 to get the information of the wintering population of the swans, geese and ducks. This is a cooperative research work with the International Waterfowl and Wetland Research Bureau (IWRB).

The meeting of the contracting parties of the Ramsar convention will be held in Japan in 1993 and those data of the waterfowl will be useful for the discussion on the waterfowl conservation of Asia.

E-2 Important Bird Areas

WBSJ has started a new research project to get the information of the important areas as a bird habitat of Japan. There are so many development plans all through the Japan. There are so many development plans all through the country and it became difficult for each conservation organizations to work against each development plan.

It is necessary for the conservation groups to get the information of the important areas and make the arrangement for the protection of the area before it will face a development plan.

This is the research to decide the priority of the conservation actions to protect the areas.

E-3 Migration Study

Yamashina Institute for Ornithology is in charge of the Bird Banding Program to study the migration route of the birds. As Taiwan and Japan are on the same migration route, co-operative work for the banding is essential.

Last year, WBSJ started new project to study the migration route of the birds using the satellite system. This system called Argos System is very useful to get the information of the migration route. A very light transmitter (40 grams) was developed last year and it made us possible to study the migration route of the Whistling Swan, *Cygnus columbianus* in 1990 and the White-naped Crane, *Grus vipio* in 1991.

A transmitter of 20 grams is expected to be developed and this 20 grams transmitter will make us possible to study the migration route of the Gray-faced Buzzard, *Butastur indicus*, from Japan to the Philippines through Taiwan.

F. International Co-operation

F-1 East Asian Bird Protection Conference

For the promotion of the communication among the bird conservationists of East Asia, East Asian Bird Protection Conference was discussed by Mr. Wu Sen-Shyoung of the Taichung Bird Society, Mr. Oh Yo-Han of the Korean Society for the Protection of Wild Animals and Ichida of the WBSJ and started in 1982.

The 4th meeting was held in Bangkok in 1989 and this is a good opportunity for the exchange of the informations and opinions of the bird conservation of the Asian region.

F-2 International Council for Bird Preservation

International Council for Bird Preservation (ICBP) is the oldest international body of the conservation and has its national sections or national representatives of some 100 countries. Taiwan and Japan have their national section of ICBP.

G. Fund Raising

It is very important for the NGO's to raise the fund for their activities.

G-1 Birdathon

This is a birdwatching marathon to raise the fund for bird conservation. It was started in US in 1975 and started in Hong Kong in 1984 and in Japan in 1985. Some 20 million Yen was raised last year for the promotion of the research work of the conservation. the Tsurui-Tancho Sanctuary, a sanctuary of the Japanese Crane was also established by this fund raising event.

Each team consisted 4 birdwatchers will try to find as many bird species as possible within 24 hours (or 12 hours in the case of Japan) and people will donate depending upon the number of the bird species found by the birdwatchers.

G-2 Charity Telephone Card

This is done by the assistance of the Nihon Telephone and Telegram Company (NTT) to add 300 yen as a donation to a 500-yen telephone card.

G-3 Bird Trust

This is a joint project with Mistubishi Trust Bank and WBSJ. People who wish to support the bird conservation will derposit the money in the bank for five years. All the interests will be donated to WBSJ for its conservation activities particularly the sanctuary management. People can get back their principal five years later. This was started in 1990.

G-4 Wild bird Society Card

The successful joint project between the Orient Corporation and WBSJ. The Orient Corporation published charity credit cards (VISA, UC, JCB) by the name of Wild Bird Society Card and 0.5 percent of the payment will be donated to WBSJ through The Orient Corporation. There is no additional charge to the card user.

This was started in May, 1990 and WBSJ got over 10 thousands card holders by the end of the year.

Table 1. Present state of Wildlife Protection Area
(as of the end of March 1989)

	No.	National Area 1,000ha	No.	Prefectural Area 1,000ha	No.	Total Area 1,000ha
Wildlife pretection area	52	424	3,339	2,852	3,391	3,276
Special protec-tion areas	41	96	565	135	606	231

Table 2. Bird listed as Extinct, Endangered or Vulnerable by the Environment Agency

Extinct	
Nycticorax calendonicus crassirostris	*Tadorna cristata*
Poliolimnas cinereus brevipes	*Columba jouyi*
Columba versicolor	*Halcyon miyakoensis*
Dryocopus javensis richardsi	
troglodytes orii	
Patrus varius orii	*Apalateron familiare familiare*
Endangered	
Diomedea albatrus	*Phalacrocorax urile*
Ciconia ciconia boyciana	*Nipponia nippon*
Haliaeetus albicilla albicilla	*Buteo buteo toyoshimai*
Buteo buteo oshiori	*Spizaetus nipalensis orientalis*
Aquila chrysaetos japonica	*Spiornis cheela perplexus*

Lagopus mutus japonicus	*Grus japonensis*
Rallus okinawae	*Scolopax mira*
Uria aalge inornata	*Lunda cirrhata*
Columba janthina stejnegeri	*Columba janthina nitens*
Chalcophaps indica yamashinai	*Keputa blakistoni blakistoni*
Sapheopipo noguchii	*Dendrocopos leucotos owstoni*
Picoides tridactylus inouyei	*Pitta brachyura nympha*
Turdus dauma amami	*Apalapteron familiare hahasima*
Vulnerable	
Podiceps cristatus cristatus	*Oceanodroma matsudairae*
Branta canadensis leucopareia	*Anser cygnoides*
Tadorna tadorna	*Pandion haliaetus haliaetus*
Haliaeetus pelagicus pelagicus	*Accipiter gentilis*
Circus aeruginosus spilonotus	*Falco peregrinus*
Falco peregrinus fruitii	*Grus monacha*
Grus vipio	*Rallus eurizonoides sepiaria*
Eurynorhynchus pygmeus	*Limnodromus semipalmatus*
Tringa guttifer	*Numenius minutus*
Synthliboramphus wumizusume	*Columba janthina janthina*
Dryocopus martius	*Erithacus komadori komadori*
Erithacus komadori namiye	*Erithacus komadori subrufus,*
Turdus celaenops	*Megalurus pryeri pryeri*
Garrulus lidthi	

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ECOLOGICAL AND PHYSIOLOGICAL STUDIES ON MIGRATION IN JAPAN AND THE CONSERVATION OF MIGRATORY BIRDS

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INTRODUCTION

In the first part of this presentation, I would like to discuss the meteorological factors influencing the migratory activities in some *Emberiza* species. In the second part, I will principally discuss, with respect to the migration route of summer birds that breed in Japan, the lighthouse collision deaths of Gray's grasshopper warblers (*Locustella fasciolata*), a bird that breeds in Hokkaido, in addition to a number of problems concerning flock formation and collisions with lighhouses when migrating, as well as the protection of habitat environments in breeding grounds.

Part 1. Meteorological Factors Influencing the Migratory Activities in *Emberiza* species

It has been said that the annual cycle of day length is the most crucial environmental factor influencing the onset of migration, and this has been confirmed by many researchers (Farner 1964; Beldhold 1974; Nakamura 1980; Nakamura, et al. 1982, etc.). In the first part of this presentation, I would like to introduce the results of our experiments on meteorological factors influencing the migratory activity of *Emberiza* species with relation to experiments involving temperature and humidity.

Buntings were put separately in small bamboo cages which were equipped with perch microswitches connected to a computer that recorded locomotor activity. The experiment was conducted by exposing migratory *E. rustica* to different artificially controlled temperatures in three chambers, each of which was lighted by two 15-watt fluorescent lamps. The photoperiod was increased from 9 to 15L and then decreased from 15 to 9L (Nakamura, et al. 1982, 1983).

Locomotor Activity in Cages in During the Dark Period.

Bird groups exposed to temperatures of 22°C increased their activity in July and August, and terminated in September, and in the 15°C group, moderate migratory activity appeared only in July. In the 8°C group, however, minor migratory activity appeared in July, and then increased activity in September. Regardless of the temperature, therefore, all birds exhibited migratory activity in spring (Nakamura, et al. 1983). A similar experiment was conducted with the reed bunting, an intermediate distant migrant. The migratory activity of the 23°C group increased in spring, and the 15°C group's migratory activity appeared only in spring, while the 8°C group showed no activity. Thus, the relationship between migratory activity and photoperiod differs in the two species (Nakamura, et al. 1978).

The temperature experiment was then conducted with two grops of rustic buntings, A and B, placed in two chambers both maintained at 15L and 9L. Temperatures were increased from 10°C to 22°C, at a rate of 2°C every 10 days. The temperature of group A's chamber during the dark period was automatically maintained 5°C lower than in the light period. Migratory activity in Group A appeared when the temperature during the light period increased to between 14°C and 16°C. The locomotor activity of Group B birds was also measured, and their migratory activity appeared slightly earlier than that of Group A birds (Nakamura, et al. 1987).

The following experiment examined how humidity influences locomotor activity in rustic buntings. Two groups of the birds were housed in rooms maintained at 20°C. Group A was kept at 50% humidity, and the photoperiod was increased from 11L to 14 L by 15 minutes per week. Group A birds began to show migratory activity when the day length attained 13L to 13.5L.

Group B, kept in 80% humidity, did not show migratory activity even when the day length was increased to 14L. However, activity appeared when the humidity was returned to 50% (Nakamura, et al. 1988).

This series of experiments suggests that bird migration is principally determined by day length, and that temperature and humidity are secondary causes.

The results also suggest that birds in the field suspend migration during hazardous weather, and resume their journey when the weather has improved.

Part 2. Migration Routes, Group Formation, and Conservation Problems of Summer Migrants

Migratory routes of birds in Japan have been ascertained on the basis of arrival and departure dates, the bird species killed in collisions with lighthouses, and field observations with handing studies.

This presentation deals mainly with summer migrants such as *Locustella fasciolata* and some other passerine species which the author has subjected to ecological and anatomical studies on bird migration. Specimens and sight records from lighthouses throughout the Japanese islands and adjacent areas including Taiwan since 1924 were used in examining the migratory routes of *L. fasciolata* and other summer migrants. The breeding grounds of *L. fasciolata* in Japan are in northern Hokkaido, while the winter grounds are supposedly in the Philippines, Celebes, Papuan islands, and so on. *Locustella fasciolata* passes through Honshu during late May and mid-June, and the autum migrants from late August to early October. Thus the migrtion period is shorter in spring than in autumn. The birds apparently take the shortest route to their destination to breed soon on arrival.

Suggested migration routes are (1) Philippines → Taiwan → Ryukyu Islands → Honshu → Hokkaido → the Kuriles or Sakhalin, and (2) Philippines → Taiwan → Fuchien → Chensoo → Southwest Korea → west coast of Honshu, whereupon this joins with route 1.

Migration routes in Honshu have also been suggested: (a) Ryukyu → Bungo Channel → Osaka Bay → Wakasa Bay → Japan Sea coast of Honshu-Hokkaido, and (b) southwest Honshu joining to (a). However, an inland route is taken in the autumn migration in addition to the aforementioned shortest route (Nakamura 1977).

The house swallow is a common and representative summer migrant in Japan. This species arrives arrives in southern Japan in early March and reaches Hokkaido in early June. After breeding, it starts its autumn migration in late August and early September. A total of 25, 167 have been banded in Japan since 1966. Among the many recoveries, one was reported in Malaysia, a total of 13 from the Philippines, and one from Taiwan. On the other hand, banded swallows from Taichung, Taiwan have been recaptured in various parts of Jsapan. all data suggests the following migration route: Philippines → Taiwan → Ruykyu → Honshu → Hokkaido.

This species gradually migrates up to Hokkaido, taking about three months and moving north with the cherry blossom season. This is because they proceed north with the appearance of their food, small insects like mosquitos and flies.

Lipid Level and Flock Formation of *Locustella fasciolata*

The lipid level in *L. fasciolata* spring migrants shows a constant level throughout the migration period in Honshu, whereas autumn migrants show some variation. This is because autumn migrants include young birds in addition to sex differences. Lipid weight in spring migrants is slightly heavier than those in autumn migrants. Weights of testes and ovaries in spring samples were measured, and heavier weights in spring samples collected from several lighthouses show great differences. Heavier weights are obtained from the samples collected at lighthouses in northern Honshu. Thus both gonads show a marked weight increase during their northern migration in Honshu. Ovaries increased from 20 mg to more than 30 mg, and tested increased markedly from 10 mg to nearly 140 mg. It is generally believed that gonadal weight in avian species directly correlates with histological development or physiological functions, and we assume that it would take many days to reach such increased states (Nakamura, et al. 1965).

I would like to refer to the work of some researchers before concluding. Nisbet et al. (1963) found some weight loss in Blackpoll warblers during migration and stated that this species can fly non-stop for 105-120 hours.

Helmes (1959) and Odum and Connell (1959) found some loss of lipid weight after long migration flights. Our results, however,indicated no significant loss in body or lipid weight in birds that had collided with several lighthouses in Honshu. We therefore conclude that this species does not fly non-stop during its migration through Honshu, but travels gradually during both the spring and autumn migration periods, stopping to feed and rest. Additionally, judging by the marked increase in gonad weight during northward migration, we can conclude that the birds spend aweek or more in spring migration, and perhaps longer during the autumn migration, to traverse Honshu. We have noted that this species arrives in southern Honshu in late May, and that spring migration lasts until mid-June. Earlier groups consist mainly of males, while later groups comprise mainly females. It is generally thought that in avian migration the males precede the females by a week to 10 days. This is true in other species such as *Locustella o. ochotensis* (Nakamura, et al. 1965a, 1965b).

Migratory birds also collide with lighthouses during migration, and according to Kawahara (1988) most collisions occur during the new moon and when it is foggy (Kawahara 1983, 1988).

The next question is why so many birds collide with the Mizunoko Lighthouse. The reasons offered are that the lighthouse is located in the middle of the Bungo Channel between Kyushu and Shikoku, and that this is furthermore in the center of the main spring migration route. Another major factor is saided to be that it is a small rock, and that in back there is no woods in which the birds can take refuge (Kawahara 1983). Additionally, once when NHK filmed the site it reported that many birds collided with the wall which was illuminated from the lighthouse base, and Kawahara emphasizes the need to stop this kind of lighting from the lighthouse base (Kawahara 1988).

A line census survey was conducted in order to ascertain the ecology of these migrating birds in their breeding grounds. It was conducted using the road census method, in which we recorded the numbers of birds seen or heard within

25 m of either side of the survey corridor, and basing the density calculations on the count. Finally, we graphically represented the relationship between the species and the number of individuals detected per hour, and compared them. The survey was conducted entirely by walking, and 7x or 8x binoculars were used to confirm the species.

Twelve sites were chosen in natural forests, mixed forests, artificial forests, orchards and vineyards, and riparian areas. Here I shall compare mixed forests with orchards and vineyards.

Hotchitoge is a mixed forest consisting mainly of *Quercus serrata*, *Q. acutissima*, and *Pinus densiflora*. During the breeding season we counted the most species, 45 (Nakamura, et al. 1987), including the ashy minivet, short-tailed bush warbler, grey thrush, narcissus flycatcher, blue-and-white flycatcher, Arctic warbler, and cuckoos. The agricultural site, which consists mainly of peach orchards and grapes, had the least species during the breeding season, with 25. Dominant species were the tree sparrow, grey starling, and brown-eared bulbul. The same trend was observed in the Enzan orchard and vineyard site, with 23 species including a few summer migrants, such as swallows and cuckoos, the fewest during the breeding season. Since farm chemicals are applied in orchards more than ten times annually the number of birds decreases. Thus the deforestation of natural forests, as well as insecticides and other farm chemicals, must be prohibited.

Additionally, development in Yamanashi Prefecture has engendered the loss of reed beds where swallows sleep, resulting in a substantial population decrease. A questionnaire survey of 50,000 homes in Kofu City revealed the existence of only 865 swallow nests (Yamanashi Wild Bird Society, 1981). We believe that future efforts are needed to preserve such habitat.

I would like to conclude by saying that the countries in which migratory bird breeding grounds are located, as well as those with wintering areas, and those through which migratory birds pass, must make international efforts for preservation.

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DISTRIBUTION, VEGETATION, AND SOCIAL STRUCTURE OF TAIWAN MACAQUES

乘越皓司
Kohsi Norikoshi

Taiwan macaques, Japanese macaques, Rhesus macaques and Crab-eating macaques belong to the fascicularis group, which is one of the four groups of Macaca genus classified by Fooden (1980). The latter two macaques, Rhesus macaques and Crab-eating macaques, range widely, but on the other hand the former two macaques, Taiwan macaques and Japanese macaque's, inhabit a rather limited area in Taiwan and Japan respectively. (Figure 1) Species living in a small and closed island, like Taiwan macaques and Japanese macaques, are apt to be exposed to the crisis of extermination because of rivals and change of environment. It is necessary to pay close attention to the preservation of such species.

In this study, I will introduce, first, the distribution of Taiwan macaques and the vegetation of their habitat, secondly, their population density and social structure in Taipingshan, Kenting, Chipen, and Yuishan, where an intensive survey was made, thirdly, the ecology of Taiwan macaques who have gone wild in Izu Ohshima Island in Japan. (Figure 2) I will also mention how the decreased number of individuals caused by capture influenced the distribution, population density, and social structure. Lastly I would like to refer to the meaning of the study on Taiwan macaques in relation to the social evolution of the Macaque genus or Cercopithecidae.

Poirier (1979) is a pioneer in the study on distribution of Taiwan macaques. From 1970s to 1980s, S. Tanaka, K. Masui, and S. Kawamura made a continuous study. Here I will introduce roughly the study made by Masui and Tanaka.

89 habitats, where some groups were recorded, widely ranged all over Taiwan and especially centered around the east and south parts. (Fig. 3) Taiwan macaques were distributed vertically over many vegetation from low land (a subtropical forest) to the forest up to 2800 meters above the sea (a mixed conifer and deciduous broad leaf forest). The habitats of high population density were a

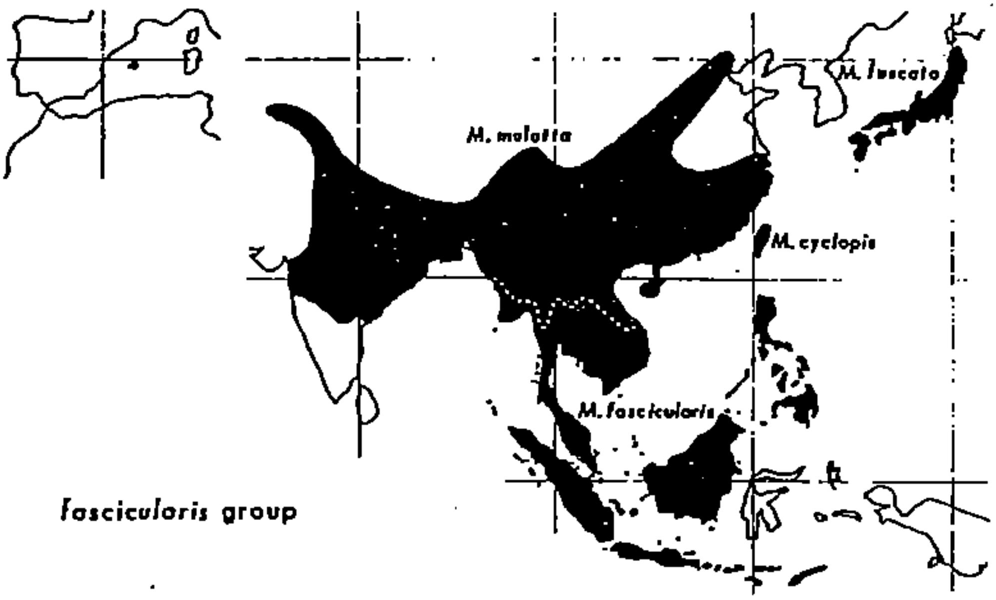

Fig. 1. (From Fooden (1980))

Approximate limits of distribution in living species of macaques (*Macaca*), showing successively less disjunct distributions of *sillenus-sylvanus* group, *sinica* group and *fascicularis* group and relatively small compact distribution of *arctoides* group. For references, see Fooden, 1976, Fig. 2, and 1979b, Fig. 1.

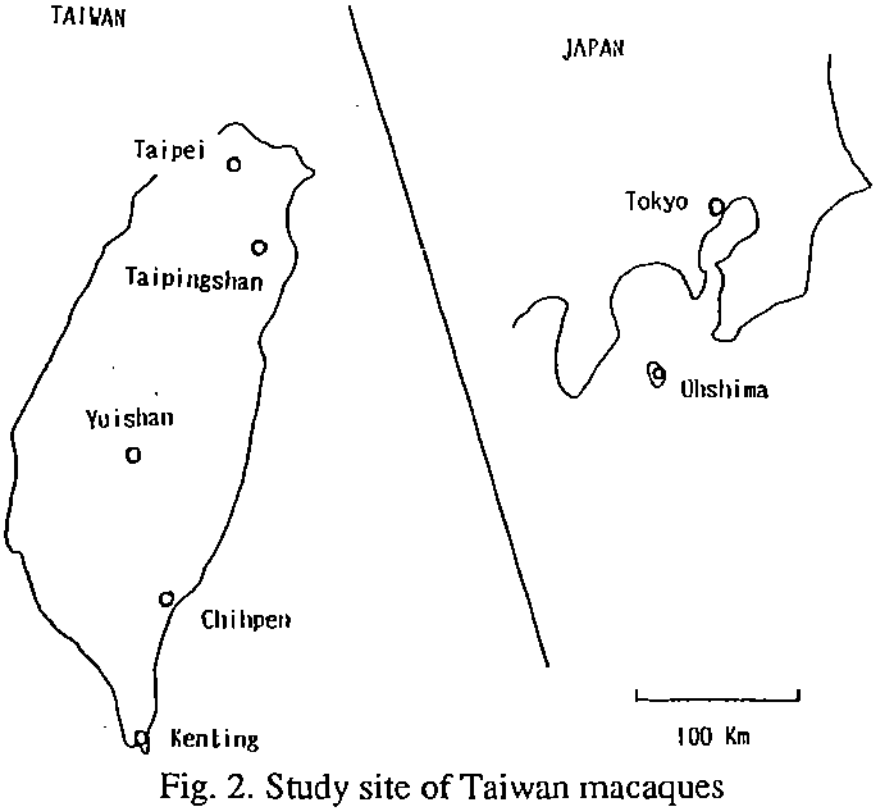

Fig. 2. Study site of Taiwan macaques

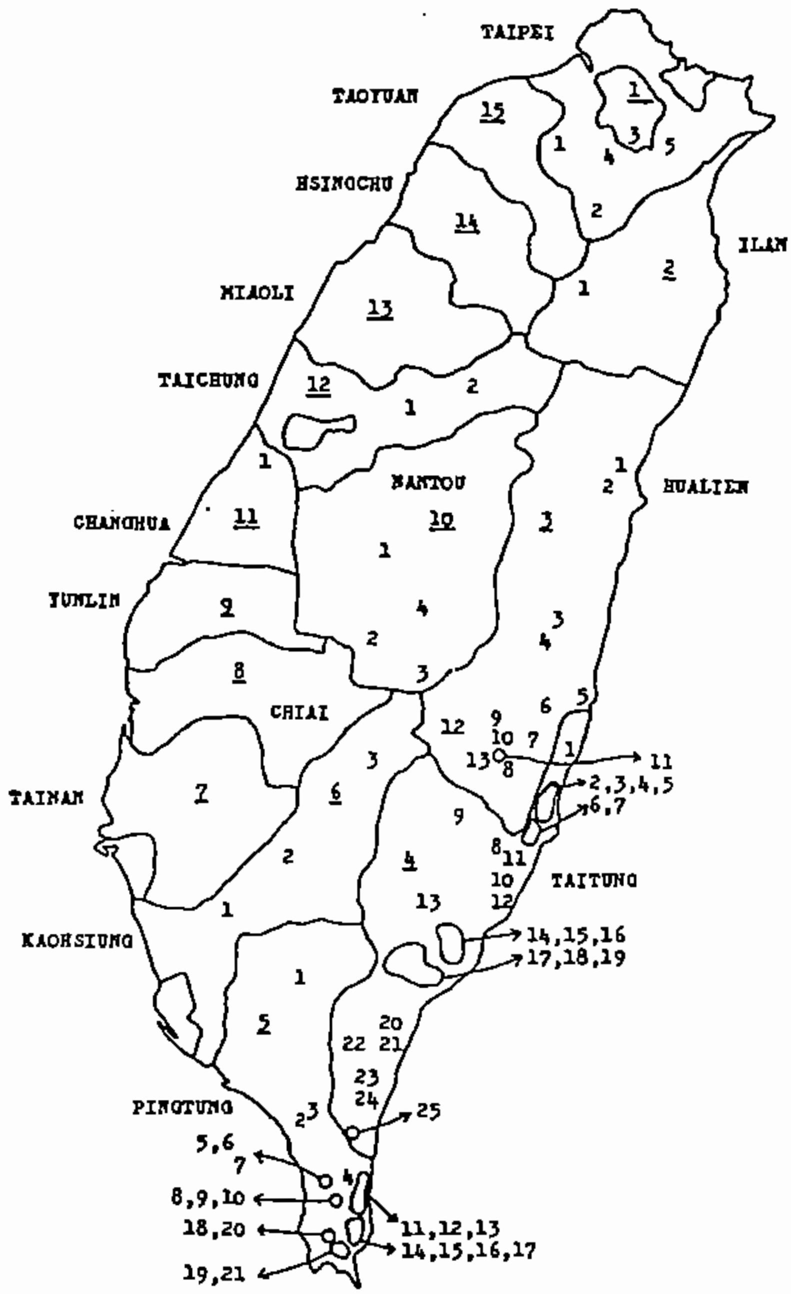

Fig. 3. (From Masui et al. (1986))

Administrative districts of Taiwan and distribution of Formosan monkeys. Figures correspond to the habitat numbers in Table 1. Underlined figures show the number of prefectures in Table 1.

temperate evergreen broad leaved forest and a subtropical forest, both below 1800 meters above the sea. Very few groups had over 30 individuals and most of the groups had from 10 to 20 individuals. In a continuous survey by Masui and Tanaka, they recorded a few areas where some identified groups became extinct a few years or ten-odd years later. This revealed that three conditions were necessary for causing the extinction of a group: high possibility of capture, decrease of woods due to land development, isolation of a group. There was a high possibility of capture in the east and south parts where many macaques were distributed, but it was not enough for the extinction of a group.

Y. S. Lin and L. L. Lee of National Taiwan University made an energetic study on the distribution of Taiwan macaques in the latter half of 1980s. This study obtained more precise findings. I hope Dr. Lee will give supplementary comments on this.

Compared with the study on the distribution of Taiwan macaques, the study on social behavior started very late, but intensive study was made in some areas in the latter half of the 1980s. Here I will touch on the outline of the study and later on the characteristics of Taiwan macaques in those areas.

Japanese researchers, S. Kawamura, K. Norikoshi, and N. Azuma, and a group from National Taiwan University have continued a survey in Taipingshan National Amusment Resort located in the northeast part of Taiwan since 1986. The following result became clear in the survey made by Norikoshi and Azuma from 1987 to 1989. Temperate evergreen broad leaved forests and coniferous forests covered the survey area of about 700 ha from 450 to 1300 meters above the sea. Five groups were always found there, and their moving areas overlapped. The average moving of one group was about 140 ha. (Figure 4) Table 1 shows the sex and age of the groups. Except CR group and CL group, whose number of individuals was not clear because they were counted from a distance, one group had about 25 individuals including several males and females. There were about four babies in one group and the birth rate including that of young females was 45%. The population density was 0.17 individuals per ha.

Kenting, where a survey has been made sine 1985, is located in the rich vegetation of subtropical forests in the southernmost part of Taiwan. There were small-sized groups with about ten individuals in one group. There were one-male group. Their main moving area was 6 ha when measured on a chart, but the actual area seemed larger. The possibility of capture was assumed to high outside the survey area, but the group which was surveyed increased in number steadily, because it inhabited the National Park, where hunting was positively prohibited.

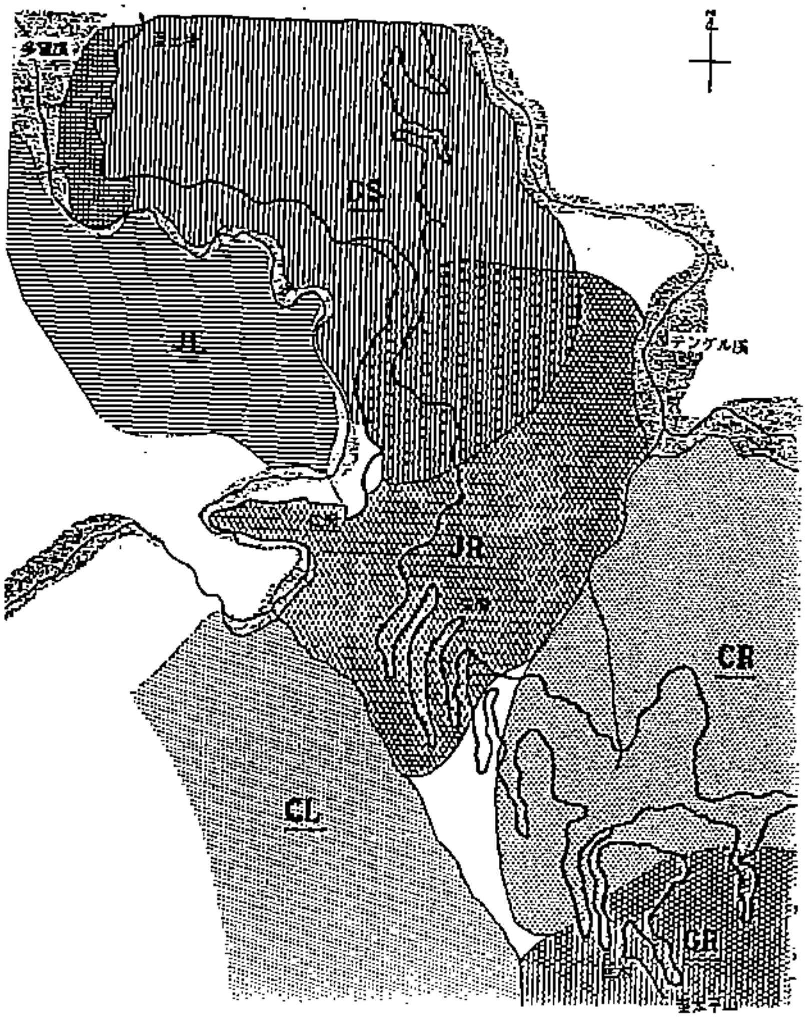

Fig. 4. Troop distribution

Table 1. Age and sex composition of the groups in Taipingshan

Group	Adult	Young	Juvenile	Infant	Baby	Total
JR	12 (6.5)	3 (1.1)	4 ( )	1 ( )	4 ( )	24
JL	9 (3.6)	5 (3.2)	2 ( )		4 ( )	22
DS	12 (3.9)	4 (1.1)	5 ( )	2 ( )	4 ( )	27
GR	11 (3.7)	1 ( )	1 ( )	1 ( )	2 ( )	24
CR	5 (3.2)	3 (1.2)	1 ( )	1 ( )	2 ( )	12
CL	6 (2.4)	2 ( )	1 ( )			12

Some interesting relation such as split of a group or relationship among groups also were recorded.

Chippen is located in the vegetation of temperate evergreen broad leaved forests in the middle eastern part of Taiwan. The groups there were rather large-sized ones with 46 individuals in one group. They were multi-male groups. Their home range was 200 ha. It was as large as that of Taipingshan.

A survey was carried along a woodland path from 1730 to 2670 meters above the sea in Yuishan, the highest mountain in Taiwan. The survey area varied in vegetation from temperate evergreen broad leaved forests to coniferous forests. Snow lies in winter and the environment is severe there. The groups there were small-sized ones with 10 individuals. They were all one-male groups.

Now I will compare the findings obtained in the above four areas. (Table 2) Though the moving area in Yuishan, whose environment was sever, was not confirmed, the relationship between moving area and vegetation was clear. For example, the moving area was small in Kenting, where vegetation was rich, but it was rather large in Taipingshan and Chippen. As for social structure of each group, Kenting, whose environment was good and Yuishan, whose environment was severe, had small sized and one-male groups of about ten individuals. Taipingshan and Chihpen had multi-male, middle or large-sized groups. Any definite relationship between social structure and environment could not be observed. It is expected that there is some relationship between social structure and capture or the history of a group. I will examine this again after introducinting the ecology of Taiwan macaques gone wild in Japan.

About half a century ago, about twenty Taiwan macaques escaped in a group from an animal park in Izu Ohshima Island, a small island in the Pacific, 100 kilometers to the south of Tokyo. These macaques have bred naturally and extended their distribution since then. They now cover almost all the large broad leaved forest in the long and narrow shape 15 kilometers from south to north and 2 kilometers from east to west along the east coast of the island. (Figure 5) Because there were shrubs 2 or 3 meters tall, barren lands due to a volcano, and houses outside the distributed area, no other places were suitable for a habitat. We are still unable to get hold of the exact number of groups and individuals, but a survey is proceeding in some areas by a group of Sophia University. I will show roughly the findings of the survey which was carried out from 1988 to 1989 by K. Kazama.

The survey area (2 km x 1 km) around the animal park twenty macaques escaped from, had some kinds of vegetation in a mosaic patter: *Castanopsis*

Table 2. Home Range, Density, Vegetation and Social Structure

	Home Range	Density	Vegetation	Social Structure
Taipingshan	140 ha	0.17	Laurel f.	M.S./M.M.
Kenting	6		Sustropical f.	S.S./O.M.
Chihpen	200		Laurel f.	M.S./M.M.
Yuishan		0.16	Laurel-Coniferous F.	S.S./O.M.
Ohshima North	20	0.75	Laurel F.	M.S./M.M.
South		0.25	Evergreen F.	S.S./O.M.

M.S.: Middle-sized group, S.S.: Small-sized, M.M.: Multi-male, O.M.: Ome-male

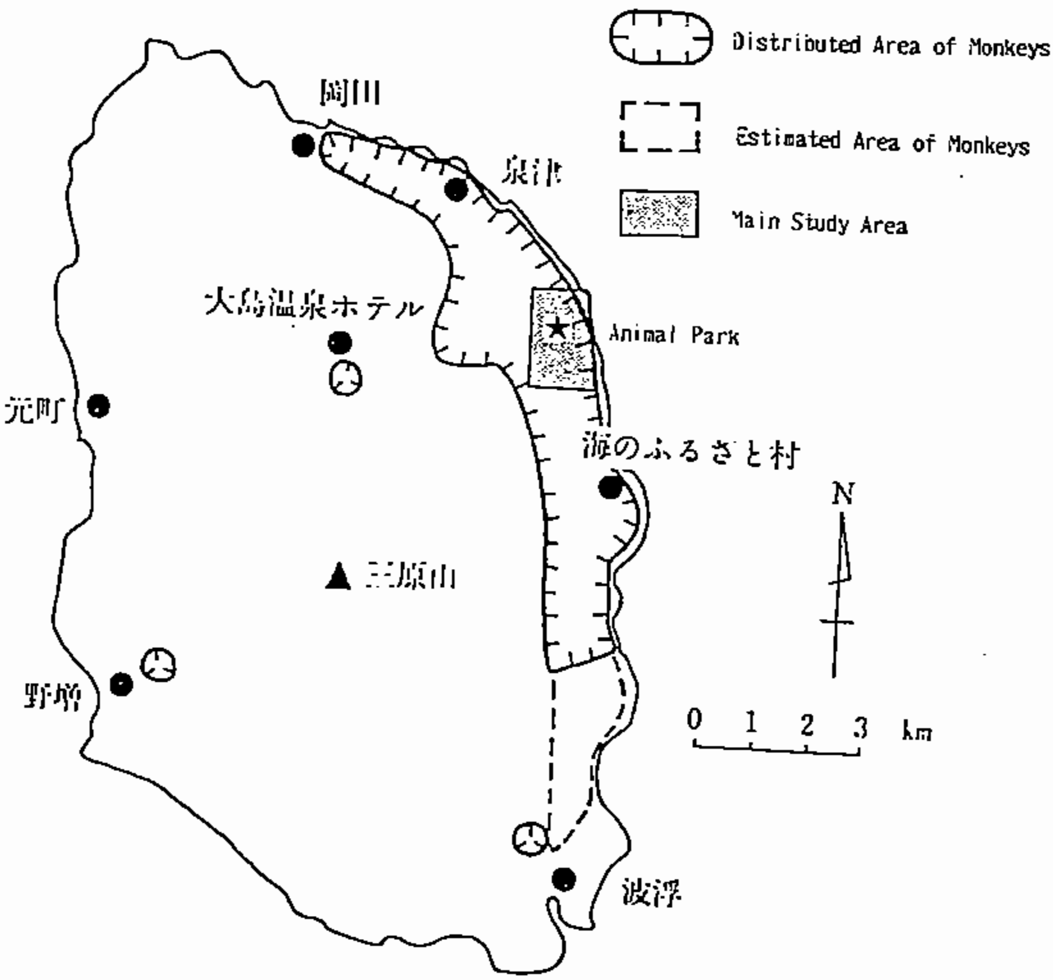

Fig. 5. Distribution of Taiwan macaques in Ohshima Island

cuspidata Forest which was abundant in food for macaques, *Prunus lannesilana* Forest which was a secondary forest, Evergreen Forest with *Pinus thunbergii*, and *Alnus sieboldiana* Forest which was a shrub 2 and 3 meters tall. Allthogether 8 groups were recorded in the survey area: 2 middle-sized groups with 25 individuals, 6 small-sized groups with 10 individuals. (Fig. 6) The moving area of KI group which was surveyed throughly was 20 ha over a year. Table 3 shows the sex and age composition of each group. The middle-sized groups were multi-male ones and the small-sized groups were one-male ones. We estimated the number of individuals of a middle-sized group to be 25 and that of a small-sized group to be 10. But the number of two small-sized groups which had their moving area in and outside the survey area was estimated to be half. Thus, individuals in the survey area totaled up to 100. The population density was 0.5 per ha. Closer observation of vegetation showed that the survey area to be divided into two parts: the north part which was covered by evergreen forests consisting of *Castanopsis cuspidata*, and the south part whcih had few forests but many shrubs. Middle-sized groups inhabited the north part where food was found in abundance, and small-sized groups inhabited the south part where food is poor. The population density of the north part was 0.75 per ha, three times as many as that of the south, 0.25 per ha. It is easy to understand that this habitat environment, specifically the amount of food supply, influences population density or social structure. In Taiwan, an artificial factor such as hunting has a great influence on the ecology of groups, but on the other hand, in Ohshima, Taiwan macaques live in a natural environment, though they are immigrants. These Taiwan macacues are very precious object of for analyzing the relation between ecological factors and social structure.

The comparision between the results of Taiwan and that of Izu Island shows the following points concerning moving area, population density and social structure. The moving area and population density of groups are related to the vegetation or the amount of food supply, though the amount is not clear in detail number. However, Taiwan and Izu Island were quite different in the relation between the size or social structure of groups and vegetation. In Ohshima, middle-sized groups inhabited a rich environment and small-sized groups poor environments. In Taiwan, However, this was not always true. It is necessary to consider historical and artificial factos such as hunting in the case of Taiwan.

The present phase of the study shows no simple phenomenon of a group becoming a multi-male group as individuals increase in number. The aspect is a little more complex. The survey in Kenting which was made by H. Y. Wu and Y.

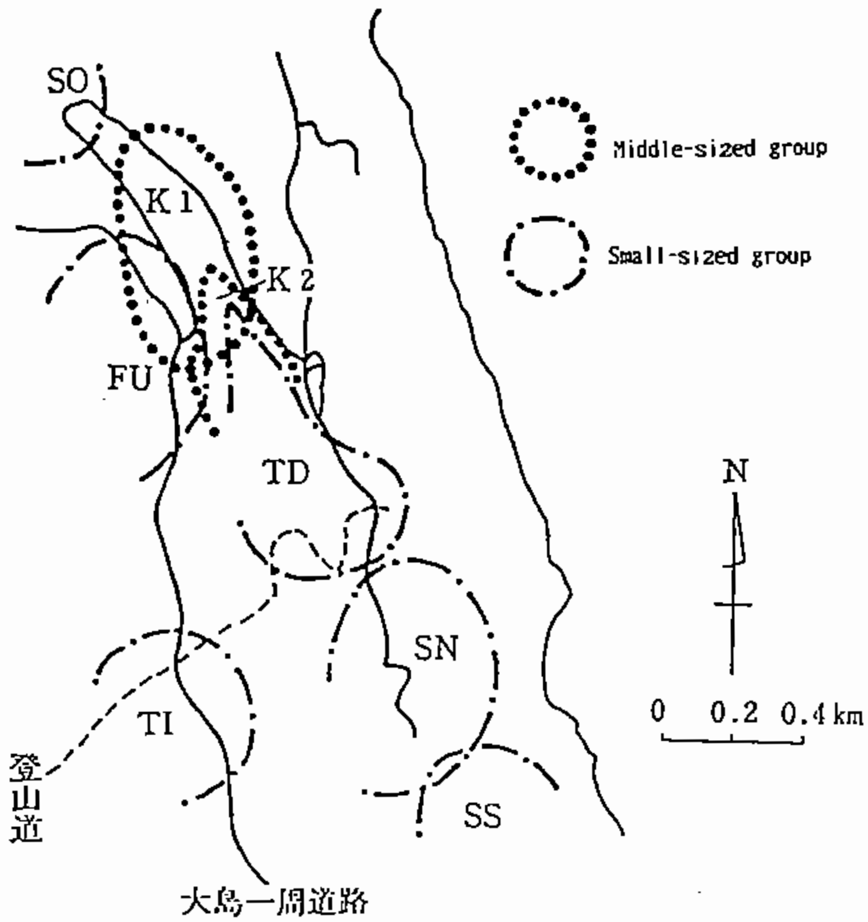

Fig. 6. Distribution of groups in Ohshima Island

Table 3.Age and sex composition of the troops in Ohshima

Group	Adult	Young	Infant	Baby	Unknown	Total
K1	6 (3.3)	5	7	2	7	27
K2	4 (2.2)	5	5	1	6	21
FU	2 (1.1)	3	1			6
TD	3 (1.2)	3	2			8
SN	4 (1.3)	1	1		2	8
SS	2 (1.1)	3	3		2	10
T1	1 (1.0)	4	2			7
S0						

S. Lin gives a very interesting result. Since hunting there was strictly prohibited, the individuals doubled in 5 or 6 years. Though the number of individuals increased, a group did not change into a multi-male, middle-sized one. The expanded group split into one-male, small-sized groups, as it used to be. It is true that the population density in Kenting is very low considering their main moving area or compared with the population density of monkeys in Southeast Asia. Capture by human beings is considered to be the main cause. If the individuals increase in number over a long period of time in the future and the population dnesity recovers to the right number for the vegetation there, the social structure may become different from the present one. I expect a further survey will be continued in view of the protection of monkeys.

In Cercopithecinae, whose society is maternal, most species of the Colobinae subfamily have one-male groups, but on the other hand most species of the Cercopithecinae subfamily have multi-male groups. It is assumed that these groups evolved in the order of a pair, a one-male group, and a multi-male group. When we consider the social structure of Taiwan macaques from this standpoint, Taiwan macaques and Japanese macaques, which belong to the fascicularis group of the Macacue genus, have symmetrical structure. Most of the groups of Japanese macaques are multi-male ones, but it seems that the groups of Taiwan macaques divide into two types accordint to the nature of their habitat: a one-male group and a multi-male one. It remains to make clear whether this characteristic is inherent in Taiwan macaques or is simply caused by capture. Here I would like to point out that capture influences the social structure or the size of groups in many ways, for example, in an indirect way caused by low population density or in a tactical way where it is easy for a small-sized group to escape being captured.

It is necessary to collect data of a group free from artificial influence caused by capture and so on as much as possible. Fortunately a protective policy of nature by the Republic of China is now bearing fruit. This policy has brought a bright future to Taiwan macaques whose sharp decrease in number was a cause of concern.

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SITUATION ON THE UTILIZATION AND CONSERVATION OF INSECT RESOURCES IN TAIWAN

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Among the animals, insects are the most abundant taxon in numbers and species. They still play an important role in ecosystem, economic utilization, research education, even though in religion, literature, arts and recreation. The first mention of insect in literature in Taiwan was 1684. But the scientific description of insects in Taiwan was from 1850s. During 1850 to 1900, most of the researchers of insect resources were Europeans. From 1900 to 1945, more and more Japanese had joined to the research of insect resources. Owing during 1945 to 1980, most of the research focused on the economic entomology, so the research of insect resources and conservation was still neglected. From 1980 some projects on the insect resources and conservation were sponsored by the National Science Council, Council of Agriculture, Department of Interior (National Parks), and Environmental Protection Agency of Exective Yuan. But, because of the limitation of man-power and bugget, now it is still lack of a broad dimentional, good planning, constant project on the insect resources and conservation. So the total papers on the insect conservation from 1980 to 1990 wasn't over 20.

In 1935, Japan-occuppied government first listed one species of swallow-tailed butterfly, *Agehana maraho* Shiraki and Sonan-as an endangered species of animal. Until on 4 Sep. 1989, 3 species of butterflies were listed on the name list of 23 species of endangered animals which announced by Council of Agriculture. On the other hand, 15 species of other insects were listed as the rare species of animals. All of these species are protected by the "Protective Law of Wild Animals" from then.

On the dimension of utilization of insect resources, from 1850 to 1900, most of the purpose of utilization for the museum and research collections. And the utilization for commercial use had started from 1906. But it had declined during the 2nd World War. From 1945 to 1960s, the utilization of insect resources, especially on the butterflies had reached to the peak, then the total export trade was about US$ 30 million per year. But from 1960s to 1970s, the commercial utilization gradually declined to only US$ 2 million per year. To 1980s, the utilization of insect resources for the export trade nearly to stop. In this paper, the impact between the conservation and utilization of insect resources was discussed. As meanwhile, some suggestions for the useful and beneficial insects, even though the insect resources for application on sightseeing and science education were mentioned too.

台灣昆蟲資源之利用與保育

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中 文 摘 要

昆蟲乃動物界中種類和數量最多之類群，在生態系、經濟利用、研究、教育、宗教及文學、藝術和娛樂上，均有其重要之角色。台灣產昆蟲之記載，始自西元1684年之方志；科學性之描述則起於1850年代。在 1850～1900年間，台灣昆蟲資源之研究以歐美人士爲主；及至日人據台至1945年台灣光復期間，已有更多之人力其中多數爲日人投入此方面之研究，而爲台灣昆蟲學研究奠定基礎。在1945～1980年間，國人之研究重點以經濟昆蟲學爲主；有關昆蟲相及昆蟲資源和保育研究，在1980年代以後，於行政院國家科學委員會、農業委員會、內政部營建署（國家公園）及環境保護署之支援下，始有較大之進展。然而，目前宥於經費及人力之限制，全面性、有計劃性及持續性之昆蟲資源調查和保育研究，亟待努力。以昆蟲保育研究爲例，在1980～1990年間，所發表之研究報告尚不及20篇；建議政府及學界今後應重視此方面之發展。

在昆蟲保育名錄方面，1935年日人首將寬尾鳳蝶（<u>Agehana maraho</u> Shiraki and Sonan）列爲天然紀念物；1989年8月4日農委會公告「保育類野生動物名錄」;在23種瀕臨絕種動物名單中，有3種爲昆蟲。另外，尚有15種昆蟲則被列爲珍貴、稀有動物。這些動物均受同年6月23日公佈實施之「野生動物保育法」所保護。

1850～1900年間，台灣昆蟲資源之利用以專家學者之研究及博物館之收藏爲主；昆蟲標本之商業性利用則始自1906年；惟在第二次世界大戰時式微。在1945年台灣光復至1960年代，爲台灣昆蟲企業之鼎

盛時期，年外銷總額在3000萬美元以上；但在1970年代末期，又告式微，年外銷總值遽降爲 200萬美元。至1980年代末期，外銷幾乎停頓，國內以此爲業者僅存 8家，且悉爲小規模經營。本文除探討此業之盛衰，利用現況外，並就未來發展和應注意問題提出建議。另外，本文並探索台灣有用昆蟲、昆蟲資源——包括家蠶、蜜蜂、食用及中藥昆蟲，和天敵昆蟲之利用概況及未來展望。同時，亦就未來昆蟲資源應用在觀光遊憩和國民科學教育上提出建議。

一、緒　言：

害蟲會直、間接爲害人畜、經濟植物、屋舍及各種倉儲物，在人類史上亦釀成多次巨災（鄒，1981）；加之現代昆蟲學家對於害蟲之研究，遠較對益蟲和其他無關害益之昆蟲者爲多，是故長久以來常人對昆蟲泰半均無好感（Metcalf and Flint,1962）。事實上，在全世界爲數達百萬種之已知昆蟲種類中，害蟲僅佔少數；多數種類或爲食蟲性動物之食餌，或扮演顯花植物授粉之角色，或擔任分解者，在維繫生態系中食物鏈和食物網之穩定，實居重要之地位。

據楊（1989a)之報告，昆蟲對人類之貢獻可就經濟利用、生態角色、教育、研究及文學、藝術、娛樂等方面觀之；其實，部份昆蟲例如糞金龜、胡蜂等，在宗教信仰方面亦有其特殊之角色（阪口，1983；趙，1989a)。然而，人口激增所導致之土地過度開發利用、森林砍伐、農藥濫用及污染等因素，不但對大型野生動、植物已造成前所未有之浩劫，對多數昆蟲亦造成極爲不利之影響；有關此等不利因素對昆蟲族群之影響，可參閱Pyle等（1981）及楊（1989a）之報告。

依Strong(1978)之報告，歐洲人侵入美洲以來至少有33種昆蟲已經由於不當之土地開發利用等因素而絕滅；Wheeler（1990）亦指出現有生物包括昆蟲，在 25～30年內，有 25～50%會在地球上消失。Opler(1976）表示，因環境變化之衝擊而造成的生物絕種現象，在海島地區則尤爲快速。台灣爲一海島區域，近三十年來之迅速開發及觀賞性昆蟲之過度利用，亦已使許多昆蟲族群式微（楊，1989a；1990a）；而昆蟲資源之利用，亦面臨瓶頸，亟待突破。另一方面，儘管在1980年代以來，國科會、農委會及內政部營建署（許及吳，1986；周等，1991），在昆蟲相、昆蟲資源調查方面已作人力及物力之投資，但依然存在些許問題。故本文除探討台灣昆蟲資源保育和利用之現況之外，將對今後此方面之發展，提出建設性之意見。

二、台灣昆蟲資源調查和保育研究：

雖然有關台灣昆蟲之記載，早見諸於金（1684）、余（1764）及謝（1807）之方志中；但科學性之觀察、調查和記載則始自1845年；及至1895年日人據台之前，大多數學者均來自歐洲。其中較為人所熟知者，例如英人 R. Swinhoe、H. E. Hobson 及加拿大籍醫生 G. L. Mackay。而日人據台至1945年台灣光復期間，參與台灣昆蟲研究之學者更多；其中較著名者，例如日人三宅恆方、松村松年、三輪勇士郎、佐佐木忠次郎、新渡戶稻雄、素木得一、江崎悌三、加藤正世及鹿野忠雄等。歐人則例如德籍之 H.Sauter和英人A.E.Wileman。有關此期間之文獻，可參閱江崎（1935a, 1935b)，高橋（1936)及朱（1973, 1974）之報告。由於這些學者之貢獻，為台灣昆蟲資源之研究奠定良好的基礎。

台灣光復之後，為解決農林作物病蟲害之問題，昆蟲學方面之研究乃偏向經濟昆蟲學部份。有關此期間之研究報告，可參閱邱（1958, 1965)及台灣農業文獻索引之資料(1956, 1966, 1974, 1983, 1987）。至於昆蟲分類之研究，在1945～1990年間約有 300篇，共發表新種及新記錄種1185種（周等, 1991)，其中1981～1990年間共有839種，約佔71%，足見近10年來此方面之蓬勃發展；當然，此亦可看出1980年以後，國科會、農委會及內政部營建署在推展昆蟲相研究，昆蟲資源調查已獲具體之進展。

1977年，行政院首有成立國家公園之芻議；其後，幾經規劃、調查及多次審議，國內第一座國家公園—墾丁國家公園終於在1984年正式成立管理處。不久，又陸續成立陽明山、玉山及太魯閣國家公園（未具名, 1987）；現在則尚規劃蘭嶼及雪霸兩座國家公園。這些國家公園成立之後，對於區內野生動物（Wildlife）之保育研究，無不積極推展；在昆蟲方面，包括蝶相、昆蟲相及相關生態研究均已先後進行。在墾丁國家公園方面有朱等（1986, 1988），陳（1985）及楊等（1988a）之報告；在陽明山國家公園，則有楊等(1987a, 1989b）及郭（1990）有關蝶類發生及生態之研究。在玉山國家公園及太魯閣國

家公園，則有楊等（1989c, 1990b）傅等（1989）、趙（1989b, 1990）及張及范（1989）之相關報告。現在尚有部份保育研究計劃正進行中。這些研究，對於生物基本資料之建立及各區保育種類之釐訂，都有莫大之助益。

另一方面，目前國家公園之解說教育亦具相當好之成果，除了野外生態和人文之解說教育活動外，各國家公園亦出版頗多精美之書籍、小冊及解說摺頁，此對國民之自然和人文教育，推動保育工作，甚具實效。在昆蟲方面，各國家公園所出版之讀物，可參閱楊（1985, 1988b, 1989d, 1989e, 1990c）、蔡（1985, 1987）及陳（1990）之出版品。

目前國內野生動物保育之主管機關，在中央為行政院農委會；該會現有「自然及文化景觀審議小組」，負責規劃、審理相關之研究和業務。如今，該會已公告淡水河紅樹林自然保留區等10個自然保留區（湯等, 1989）；這些自然保留區亦提供許多昆蟲之良好庇護所。有關昆蟲資源之調查雖尚未及於所有自然保留區，但部份已推展之中；現已完成之報告，例如楊等（1986a, 1987b）哈盆昆蟲相調查；陳（1987, 1988a, 1988b）之蝶類資源調查及楊（1989a, 1990a）有關台灣昆蟲保育和利用之調查。

由於國民生活水準提高，遊憩品質之要求也隨之提昇；如今，國內觀光局有風景區之規劃，林務局亦有森林遊樂區之設置（沈, 1987），如欲提昇知性之旅之水準，則區內自然資源，包括昆蟲資源之調查，實有待展開；因為沒有良好的自然資源調查研究，即無法提供周全的解說素材。

三、台灣昆蟲保育之名錄和法令：

台灣有關昆蟲保育名錄之擬定，雖早溯至1935年日人之將寬尾鳳蝶（Agehana maraho Shiraki and Sonan）列為天然紀念物，嚴禁捕捉（朱, 1973）；但正式名錄之釐訂卻延遲至1989年6月23日「野生動物保育法」在立法院三讀通過，由總說明會公佈後；在同年8月4日由

農委會公告，並依「野生動物保育法」加以規範（行政院農委會，1989）。

其實，在此之前國內部份關心野生動物保育之學者。在1985年而已草擬43種台灣亟待保育之野生動物名錄；其中包括4種昆蟲，此即寬尾鳳蝶(A. maraho Shiraki and Sonan)、大紫蛺蝶（Sasakia charonda formosana Shirôzu)、珠光鳳蝶（Troides magellanus C. and R. Felder)、黃裳鳳蝶（T. aeacus kaguya Nakahara and Esaki)（未具名，1985）。

而在野生動物保育法審議期間，行政院農委會爲愼重起見，發函各學術、研究機構及相關民間團體，共同擬議野生動物保育名錄，匯集之後再經「自然及文化景觀審議小組」委員和相關專家、學者多次討論，終於擬定「保育類野生動物名錄」。此名錄分瀕臨絕種保育類野生動物及珍貴稀有保育類野生動物兩類；在昆蟲方面，前者共有三種，此即寬尾鳳蝶、珠光鳳蝶及大紫蛺蝶。而後者則有十五種，此即表一所列：包括蝶類二種，同翅目二種，蜻蛉目一種、鞘翅目八種、直翅目一種及竹節蟲目一種；這些種類均屬於大型、漂亮，有過度利用之虞，或分佈地區狹窄，如遭過度捕殺，或棲地遭到破壞而有絕種之虞的種類。不過，儘管由於台灣昆蟲相、昆蟲資源調查研究尚待投入更多人力、物力積極研究，此名錄或有缺失，但仍不失爲現階段較好之保育措施；況此名錄在實施一個階段之後如有問題，尚可透過審議小組之審議、討論加以修正。

除了種類之立法保護之外，特殊棲地之保護亦甚爲重要；以日本爲例，境內即有處10螢火蟲發生地及4處蟬類棲地之立法保護措施（加藤及沼田，1984)。陳（1981）及Ishii（1990）指出，台灣亦有多處「蝴蝶谷」，此爲蝶類大量出現之特殊棲地，這些特殊棲地是否亦應立法保護，仍有待今後更進一步探討。

至於法令方面，對於保育類野生動物，亦可依「國家公園法」予以保護。而瀕臨絕種保育類野生動物，例如珠光鳳蝶，尚可依「自然及文化資產保存法」加以保護。另外，在自然保留區及國家公園範圍內進行昆蟲採集或調查時，則應依法令之規定辦法申請；否則一旦違

法而被查獲，便會遭懲處。

四、台灣昆蟲資源之利用：

對於台灣昆蟲之商業性利用，楊（1989a, 1990a）曾進行調查；而周（1991）之綜述提及台灣昆蟲資源之利用，可概分學術研究及教學材料、害蟲生物防治、環境品質的指標生物、觀光、商業及工業價值、農作物授粉、食用、藥用及宗教信仰等。然而，這些利用方式是否會和保育發生衝突，實頗值得注意。

人類食蟲歷史，由來已久（鄒, 1981)；楊（1990a）曾對台灣地區人食及動物食用之昆蟲進行調查，其中人食之昆蟲包括台灣大蟋蟀（Brachytrupes portentosus）等共約30種或類。動物食用部份，則以養鳥用之擬穀盜類（Tribolium spp.）及養魚用之黑蟋蟀(Gryllus bimaculatata）和紅蟲（搖蚊幼蟲，Chironomus spp.）爲大宗。

而養蠶及養蜂則爲人類較有系統利用昆蟲之產業；據台灣省農林廳之年報(1982～1988)，蜂蜜及蜂王漿之產值在691,200～1,253,179仟元之間，有逐年增加之趨勢；但蠶繭之產量和產值由1982～1988年之14,117～128,759 公斤，產值由286,070仟元降爲182,331仟元，有明顯銳減之現象；此兩種產業之變化實值得注意。在養蠶業方面，是否應加強下游工業，例如紡織品之加工和開發，或導向僵蠶、冬蟲夏草之利用及生物技術方面之發展，有待進一步評估。至於養蜂業，除傳統蜂產品之利用外，其授粉之角色及其他授粉性昆蟲之利用也有待投入更多的人力和物力研究開發。

在中藥昆蟲利用方面，據楊(1990a）之報告，除冬蟲夏草之外，此方面之利用在中藥藥材僅佔 5%以下；而在大台北地區之中藥店中之34種或類之中藥昆蟲中，以冬蟲夏草、蟬蛻、五倍子、螵蛸、蠶蛻、白僵蠶、蠶砂、蜂蜜及非昆蟲類之金蠍、地龍乾（水蛭）和蜈蚣較常利用。惟多數此類產品，台灣都有，且均可生產，但目前卻悉由大陸轉口進入中藥店利用；其中冬蟲夏草部份，在大台北地區每年之消費額高達 5,900萬元，頗具市場潛力。至於胡蜂在食用方面之利用，

「蜂酒」每瓶零售價在300～500元間，「蜂筍」每公斤零售價約1000元；成蟲在神像入神之用量，據趙（1989）之報告，每年均約6 萬隻，總值約600萬元。

在生物防治方面，台灣早在 1934 年即利用赤眼卵產寄生蜂（Trichogramma chilonis）防治甘蔗害蟲－黃螟（Argyroploce schistaceana）、條螟（Proceras venosatus）及二點螟（Chilotraea infuscatella）等，成效卓著。目前在農委會及台灣省農林廳推廣之下，亦利用玉米卵寄生蜂（T. ostriniae）防治玉米螟（Ostrinia furnacalis）；亮腹釉小蜂（Tamarixia radiata）防治柑桔木蝨（Diaphorina citri）；紅胸葉蟲釉小蜂（Tetrastichus brontispae）防治紅胸葉蟲（Brontispa longissima）及藉著捕植　防治多種葉蟎（楊，1986b；楊及朱，1985；周　，1988）。

水棲昆蟲爲淡水魚類之重要食餌，楊及林(1986c)，楊等（1986d，1990d，1990e）及林等（1988)之報告。除就七家灣溪、北勢溪及內外雙溪進行水棲昆蟲資源調查之外；亦藉水棲昆蟲對不同水域環境之適應性，作爲河川水質污染程度之評估（洪等，1986；楊等,1983，1990f)；目前環境保護署正推展此方面之環境教育工作（莊，1980）。

在展示活體昆蟲方面，台北市立動物現已有「蝴蝶園」及「蝴蝶步道」之設置（林，1986），已吸引甚多之遊客；而陽明山國家公園亦有「蝴蝶花廊」之規劃（呂等，1988）。除此，1990年起，埔里木生昆蟲博物館除承繼傳統之靜態型昆蟲展示外，亦設有小型之活體昆蟲園。另外，像「黃蝶翠谷」，多年來即吸引不少觀光客前往欣賞黃蝶活動之奇景（陳，1981）；不過，位於美濃之「黃蝶翠谷」卻由於擬建美濃水庫（陳,1990)，此勝景能否重現，尚待觀察。而把昆蟲資源應用在教學及「知性之旅」等活動，在1970年代以後已逐漸增加，尤其受到中、小學生及家長之歡迎；在此部份，國立科學教育館、中華昆蟲學會及各國家公園在推展此類科學教育工作上，均扮演著重要之角色（楊，1989f；中華昆蟲，1990）。

在台灣，昆蟲之商業性利用，以昆蟲加工業最受矚目；然而，亦

由於此業曾因過度利用而迭遭國內外保育界人士所詬病。有關台灣昆蟲加工業大、中盤商之分佈，經營方式、經營時間、貨源、銷售對象、製作方式，所利用之種類、數量及價格，及業者面臨之問題和未來之發展，可參閱楊（1990a）之調查報告。

台灣昆蟲加工業發展甚早；據朱（1973）及陳（1981）之報告，1906年日人朝倉在埔里經營蝶類標本；1918～1920年間和河村合設「埔里社特產株式會社」，販賣蝶類等昆蟲標本及此地特產。其後，日本岐阜市之「名和昆蟲研究所」蝶類鱗片較印領帶衣物之技術開發成功，繼該社購入大量蝶類標本，開台灣產昆蟲標本大量利用之濫觴！不過在第二次世界大戰後，此業因戰爭及景氣衰退逐走下坡；一直到台灣光復後數年，又重新恢復榮面，在1960年代甚至取代巴西，而成爲世界之冠；然而，此榮面一直持續到1975年左右，由於多種因素之衝擊，而陷入困境，使此業目前幾成爲「黄昏工業」；有關此業之盛衰，可參閱Marshall（1982）、Morton and Collins（1984）、Severinghaus（1977）、Unno（1974）、陳（1981）及楊（1989a）之報告。

據Owen在1971年之估計，台灣在1960年代蝶類外銷總值約3000萬美元（New, 1984）；但Marshall在1982年之報告指出，在1970年代末期已遽降爲200萬美元左右。Pyle 之報告(1981)則指出，在蝶類外銷盛期，台灣每年之蝶類消耗量爲1500萬～5億隻之間；但由楊(1990a)之調查發現，此種大量利用及外銷盛況不再，目前專營昆蟲標本行業者已減爲11家，然由作者最近資料得知現僅存 8家，經營規模已甚小了！

值得注意的是，據楊(1990a）之報告，台灣目前所利用之昆蟲不管是國內產的種類，或購自國外之種類，有部份爲國內野生動物保育法所保護之保育類野生動物；此例如珠光鳳蝶、大紫蛺蝶及寬尾鳳蝶等。另有一部份係名於「國際瀕臨絕種生物貿易協約」(CITES）所列附件一及二之種類；此例如亞歷山大鳥翼蝶(Ornithoptera alexandrae）、高山天堂蝶（O. chimaera）、紅頸鳥翼蝶(Trogonoptera brookiana）及大青蝶（T. brookiana albescens）等。爲落實保育

類野生動物，包括昆蟲，除加強宣導、取締之外，對於進口之動物標本，亦應嚴加管制，以免CITES附件一、二所列之動物非法流入利用，而在國際保育界引起軒然大波。因爲只要循合法手續申請，仍可引入這兩類動物。

五、台灣昆蟲資源保育及利用所面臨之問題：

雖然台灣昆蟲學之研究已有 140餘年之歷史，目前所記錄之昆蟲種類亦有17,609種，但據周等（1991）之報告，由國人命名或記錄者，僅佔7%。而據朱（1990）之估計，目前已知種比率僅9%，可見此方面之調查落後日本或歐美先進國家甚多。有關台灣昆蟲相及昆蟲學研究發展，可參閱許及吳（1986)、楊（1989d）及周等（1991）之報告。

楊（1989a)之報告指出，土地過度開發，農藥過量使用及污染等不利因素均會直、間接影響昆蟲族群式微或絕種，因此儘速進行全面性之昆蟲相或昆蟲資源調查，實乃刻不容緩之事。周等（1991）之報告建議目前宜分區全面進行採集，並建議透過國際性之合作，資助國人前往國外採集、加強文獻之蒐集，儘速發表台灣昆蟲名錄、出版專論性研究與鑑定手冊等具體措施。然而，回顧國內目前國科會雖從1980年起即贊助昆蟲相調查計劃，但參與之人員實有待增加，經費亦有待持續支援。儘管昆蟲分類學有層級之分類之分，但由於國內許多分類群由於以往研究甚少，欲在短期間內達到最高層次實有實際上之困難；而據作者所知雖有不少年輕一輩學者欲從事此方面研究，卻未能得到經費支持和鼓勵，殊爲可惜！

至於國家公園及自然保留區內之昆蟲資源調查，雖目前有各國家公園及農委會全力支持；但由於保育研究經費與年俱減，往往未能作持續性之支援，建議如宥於經費未能作較長期性之支持，盼能多鼓勵各管理處之在職人員自行研究，並多和專家學者研商、諮詢。另，國家公園現行之補助研究生進行自然資源調查研究，亦不失爲權宜措施。至於農委會之保育研究，亦由於經費之限制，未能擴及全部之自然保留區，盼望未來成立農業部時，此方面之經費宜多寬列，以鼓勵更

多之專家、學者投入此方面之研究。另外，針對各國家公園之特有之保育類動物和政府已公告之保育類野生動物，在昆蟲部份由於大多數種類之基本生物學和生態學資料依然不足，應予優先進行調查研究；對於特殊之昆蟲棲地，例如大武山自然保留區內「紫蝶幽谷」之分佈和蝶類生態習性，亦宜及早進行研究。

在林務單位方面，由於林業政策的改變，經營方式已由已往之伐木轉爲森林遊樂、國土保安及森林保護等方面；目前林務局亦已編輯「台灣野生動物資源調查手冊」(共六冊，其中兩冊爲昆蟲)(俞,1990)，欲作第三次台灣森林資源及土地利用調查，但願能結合各學術、研究單位的學者、專家，蒐集、建立更多昆蟲資源之資訊。

至於昆蟲資源利用方面，在昆蟲標本加工及活體利用部份，建議：(1) 產品應精緻化、藝術化；(2) 人人要有保育的觀念，不捕捉稀有之種類，遵守CITES 及野生動物保育法之規定；(3) 發展昆蟲資源在教育方面之功能；(4) 海關之商品分類對於保育類昆蟲之進出口應予分類管制。在觀光遊憩方面，建議：(1) 民間成立「昆蟲園」、「蝴蝶園」，以台灣蝶類及昆蟲之特色，吸引觀光客；並發展昆蟲或蝶類之人工養殖技術，使此具特色之自然資源能作教育及遊樂用途。(2) 公營或民間團體方面，可就當地特色，規劃「蝴蝶牧場」或「蝴蝶花廊」之類的設施，進行「知性之旅」的活動。並多出版摺頁、小冊或書籍，以廣爲推廣。(3) 林務及退輔會系統之山區闊葉林地，均爲良好昆蟲棲地，可依特色類規劃賞蝶、賞鳥步道；還有，各地區之公園在栽培花木時亦不妨考慮栽植蝶類及吸蜜性昆蟲之蜜源植物，以吸引蝶類等訪花性昆蟲造訪。

而在蜜蜂、家蠶等有用昆蟲之利用方面，建議負責此兩項產業研究、開發和推廣之台灣省蠶蜂改良場能升格爲有用昆蟲試驗所（或資源昆蟲試驗所），除繼續承繼此兩項產業之外，並研究開發其他有用昆蟲，例如食用、藥用、觀賞性昆蟲及授粉性、食糞性昆蟲之培育和利用，善用昆蟲這種寶貴且可永續利用之自然資源。

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表一、國內保育類昆蟲名錄

1.瀕臨絶種保育類昆蟲

中名及分類地位	學名	英名
節肢動物 (Arthropoda)		
昆蟲綱 (Insecta)		
鱗翅目 (Lepidoptera)		
鳳蝶科 (Papilionidae)		
寬尾鳳蝶	Agehana maraho	Brood-tailed fwallowtail butterfly
珠光鳳蝶	Troides magellanus	Bird-winged butterfly
蛺蝶科 (Nymphalidae)		
大紫蛺蝶	Sasakia charonda formosana	Large purple fritillary

2.珍貴稀有保育類昆蟲

中名及分類地位	學名	英名
昆蟲綱 (Insecta)		
鱗翅目 (Lepidoptera)		
鳳蝶科 (Papilionidae)		
曙鳳蝶	<u>Atrophaneura</u> <u>hori-shana</u>	Highland red-belly swallowtail butterfly
黃裳鳳蝶	<u>Troides</u> <u>aeacus</u> <u>kaguya</u>	Heng-chun birdwing butterfly
同翅目 (Homoptera)		
蟬科 (Cicadidae)		
臺灣爺蟬	<u>Formotosema</u> <u>siebohmi</u>	Formosan giant cicada
白臘蟲科 (Fulgoridae)		
渡邊氏長吻臘蟲	<u>Fulgora</u> <u>watanabei</u>	Watanabei's lanternfly
蜻蛉目 (Odonata)		
勾蜓科 (Cordulegasteridae)		
無霸勾蜓	<u>Anotogaster</u> <u>sieboldii</u>	Jambo dragonfly
鞘翅目 (Coleoptera)		
吉丁蟲科 (Buprestidae)		
妖豔吉丁蟲	<u>Buprestis</u> <u>mirabilis</u>	Brilliant jewel beetle
叩頭蟲科 (Elateridae)		
虹彩叩頭蟲	<u>Campsosternus</u> <u>gemma</u>	Rainbow sheath click bettle
金龜蟲科 (Scarabaeidae)		
臺灣長臂金龜	<u>Cheirotonus</u> <u>macleayi</u> <u>formosanus</u>	Formosan long-armed scarab
鍬形蟲科 (Lucanidae)		

中名及分類地位	學名	英名
臺灣大鍬形蟲	Dorcus formosanus	Formosan giant stag beetle
長角大鍬形蟲	Dorcus schenklingi	Formosan long-fanged stag beetle
天牛科 (Cerambycidae)		
霧社血斑天牛	Aeolesthes oenochrous	Wu-she blood-spotted longhorned beetle
步行蟲科 (Cacrabidae)		
臺灣食蝸步行蟲	Damaster blaptoides hanae	Formosan snail-eating ground beetle
臺灣擬食蝸步行蟲	Coptolabrus nankototaijanus miwai	Nankototaijanus Formosan false snail-eating ground beetle
直翅目 (Orthoptera)		
螽　科 (Tettigoniidae)		
蘭嶼大葉螢	Phyllophorina rotoshoensis	Lan-hsu giant katydid
竹節蟲目 (Phasmida)		
竹節蟲科 (Phasmidae)		
津田氏大頭竹節蟲	Megacrania alpheus	Big-headed stick insect

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THE PRESENT STATUS OF THE LANDLOCKED FORMOSAN SALMON

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The Formosan landlocked salmon is a salmonid which occurs uniquely in the upper streams of Tachia River in Taiwan. This salmon was first named as *Salmo formosanus* by Jordan and Oshima in 1919. In 1985, Watanabe and Lin tried to conclude that there was only one endemic subspecies of salmonid fish in Taiwan, and designated the fish as *Oncorhynchus masou formosanus*. Recent studies on the morphometric and the meristic values of the Formosan salmon have shown that this salmon is more closely related to *Oncorhynchus masou masou*, a salmon subspecies widely distributed in northern Japan, than to any other members of the Pacific salmon (Genus *Oncorhynchus*). In addition, studies of the mitochondrial DNA of both the Formosan salmon and *Oncorhynchus masou masou* have revealed the value of the base pair-substitution between these two salmons. The common substitution value was 0.202%; the highest, 1.59%. Based on this information, it is thus speculated that the Formosan salmon might have originated from the salmon population in the Sea of Japan at approximately 100-800 thousand years ago.

The Formosan salmon lives in the highland streams where water temperature remains below 16°C in the year round. In the 30's the Formosan salmon were widely distributed in six upper streams of Tachia River. In the recent years, the distribution of this salmon seems to be limited to the Chichiawan Stream, one of the six tributaries of Tachia River where the fish used to occur. It is likely that the environmental changes caused by deforestation, farming, and construction of the sand-retention dams have to account for the population decrease.

This salmon is a glacial relic and hence was once considered as a "natural monument". For the same reason, it has attracted very wide attention in the field

臺灣大甲溪上游產陸封性鮭魚的現況

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中 文 摘 要

現存於台灣大甲溪上游七家灣溪一帶的台灣陸封性鮭魚（亦即櫻花鉤吻鮭，或稱台灣鱒、次高山鱒、櫻鱒、梨山鱒、臺灣馬蘇麻哈魚、三文魚或石川氏鮭魚；泰雅族語則稱之爲本邦（Bunban））是本省所產的一種特有種魚類。在五十年前，櫻花鉤吻鮭廣泛分布於大甲溪上游的六個支流，並且曾經是當地泰雅族原住民的主食之一，但是目前櫻花鉤吻鮭只出現於此六支流之一——亦即七家灣溪裡。這種族群量減小的現象，已顯示出此特有種鮭魚正面臨瀕臨滅絕的危機。在另外一方面，櫻花鉤吻鮭爲冰河時期的遺物，因此在學術上，其種源以及在地理分布上的位置，一直相當受到重視。本文乃就目前對此鮭魚現況的瞭解做一說明，內容主要敘述：

（一）這些陸封性鮭魚的分類地位；

（二）形成陸封性的可能經過；

（三）生存的環境以及人類活動所加諸的影響；

（四）今昔族群量的變動情形；

（五）櫻花鉤吻鮭在學術上的價值

（六）目前有關的保育措施。

櫻花鉤吻鮭爲臺灣特有種生物中迫切需要施以保護的種類之一，是以已於民國七十三年經政府依法列爲瀕臨滅絕的動物，嚴格加以保護。在方法上，不但全面禁止捕撈這些鮭魚，同時也設法復原先前受到人爲改變的棲所環境。在另外一方面，一項復育這些鮭魚的計畫也正在進行中，以期使此鮭魚的族群能恢復起來，而不致於滅絕。

現存於台灣大甲溪上游七家灣溪一帶的台灣陸封性鮭魚（亦即櫻花鉤吻鮭，或稱台灣鱒、次高山鱒、櫻鱒、梨山鱒、臺灣馬蘇麻哈魚、三文魚或石川氏鮭魚；泰雅族語則稱之爲本邦（Bunban））由於屬於冰河時期的遺物，因此其種源以及在地理分布上的位置，一直相當受到重視。以下謹就我們對這些鮭魚所做的瞭解，以及這些鮭魚的現況做一説明。

一、這些陸封性鮭魚的分類地位

在分類方面，西元1919年，Jordan（喬丹氏）和Oshima（大島正滿氏）根據兩尾標本的形質將此陸封性鮭魚命名爲Salmo formosanus Jordan and Oshima。1934年，大島正滿根據其他標本的鱗片構造及活魚體側有紅色斑點等特徵，將學名改爲Oncorhynchus formosanus。1935年，大島正滿到大甲溪上游採集，鑑定標本後，認定其與日本北方所產的櫻鮭相同，學名因此再度更改，成爲Oncorhynchus masou（Brevoort）。Behnke等在1962年再度就此鮭魚的分類問題加以探討，認爲這些陸封性鮭魚在分類上可能出現有以下三種情況：它可能是全部都屬於同一個種，這時應將它視爲櫻鮭O. masou的一個亞種。不過，這些鮭魚也有可能是含有二或三個種。 Watanabe 和Lin 在1985年亦認爲此陸封性鮭魚應該是櫻鮭的亞種，並將學名定爲 Oncorhynchus masou formosanus(在本文中以下即以「櫻花鉤吻鮭」)稱之。

的確，將櫻花鉤吻鮭與Oncorhynchus屬內其他魚種之間相互比較的結果亦顯示：櫻花鉤吻鮭與櫻鮭亞種Oncorhynchus masou masou之間，在許多計量形質上，要比其他魚種之間來得接近。當以Average-taxomonic distance爲依據，以UPGMA法處理，所得的樹狀種緣關係圖亦顯示櫻花鉤吻鮭與櫻鮭亞種之間的類緣關係爲最密切（Jan et al. 1990）。

在另外一方面，經研究此七家灣溪所產的鮭魚的粒腺體 DNA後，發現這些個體的基因型與日本櫻鮭Oncorhynchus masou族群的基因型之間非常相似。由 Nei及Li的公式所計算出上述兩基因型內的鹼基對取代率爲0.202%（最高值爲1.59%）。由這個值來換算，顯示臺灣櫻

鮭與日本櫻鮭是在相當於101,000～795,000年之前分離開來。根據櫻花鉤吻鮭的分類，命名及分布情形來看，這些鮭魚可能是在 100,000～800,000 年前由日本海經對馬海峽（而非經由日本的太平洋岸）移棲過來的（Numachi et al. 1990）。同時，臺灣櫻鮭族群的粒腺體DNA呈現均質現象，這可能表示此族群正處於萎縮時期。

儘管如此，就分類地位這一方面而言，櫻花鉤吻鮭的學名到底是否應爲Oncorhynchus masou formosanus，亦即與日本所產的櫻鮭（即上述的櫻鮭亞種）一樣，皆爲Oncorhynchus masou種下的一個亞種；還是櫻花鉤吻鮭與日本所產的櫻鮭只是經地理隔絕而形成的兩個族群，到目前爲止，可以說仍是不十分清楚，這是有待進一步探討的一個課題。

二、形成陸封性的可能經過

依據櫻花鉤吻鮭與日本櫻鮭之間相似的情形來看，我們對櫻花鉤吻鮭陸封性的形成大概可以做成以下這樣的推理。櫻花鉤吻鮭原來與一般生長在溫帶的鮭魚一樣有「洄游性」，成熟的鮭魚每年秋季會從大海溯河逆流而上，洄游至其出生的河流上游交配、產卵；雌魚產卵後即死亡，雄魚則順河而下，回歸大海；魚卵孵化後，次年春天再往下游出海，成熟後，又回返老家交配、產卵，如此循環不已。後來因爲地殼劇烈變動，臺灣地形隆起，溫度升高，平緩的河川變爲陡峭、短急，部分河川下游流水改變了流向，部分溪谷及河口因崩坍堵塞，阻斷其歸路，使櫻花鉤吻鮭生存受到威脅。現僅獨存於大甲溪上游，係因該區域尚維持平緩的地形，得以提供其生存環境，但也因此導致此鮭魚喪失了海陸洄游性，而成了無獨有偶的陸封性鮭魚，而同時體型也變小了許多。

三、生存的環境以及人類活動所加諸的影響

櫻花鉤吻鮭屬於冷水性魚類，終生棲息於水溫16℃以下兼具貧營

養鹽性的高山溪流中 (Lin and Chang, 1989)，但由於森林植被的變化導致了溪流水溫的升高，以及民眾毒、電、炸魚等過度的漁獲行爲，加上不當的農藥施用等影響了此鮭魚食料（如水棲昆蟲等）的生存，而攔砂壩的築設分段阻隔族群的移動，也同時影響了其生殖與繁衍。

四、今昔族群量的變動情形

五十年前，櫻花鉤吻鮭廣泛分布於大甲溪上游的六個支流。櫻花鉤吻鮭曾經是當地泰雅族原住民的主食之一（Aoki 1917, Kano 1940），但是目前只出現於此六支流之一——亦即七家灣溪裡。

在族群大小的變化上，自1987年9月至1989年1月間，七家灣溪內櫻花鉤吻鮭魚自將近 1,800尾降至約 650尾。此外，族群量呈現明顯的季節變化，亦即在 7至10月間，族群量相當穩定，但是在冬季則有減少的趨勢。當水溫低於12℃時，躲藏在洞穴中魚的比率增加。在上述期間，此鮭魚的族群量一直在減少。魚群的減少，主要是幼魚數量持續在減少，而年長魚的數量則較爲穩定。年長魚與幼魚的分布型態相近；在河段內，二者族群數在時間上的變化，可能與與攔砂壩的位置有很大的關聯。在另外一方面，洪水及攔砂壩對鮭魚族群及分布也有很大的影響 (Lin et al., 1987; Lin et al. 1990)。綜合而言，上述族群量急劇減少的現象，佐以有關粒腺體DNA 的研究結果，在在顯示著櫻花鉤吻鮭目前已面臨絕滅的危機。

五、櫻花鉤吻鮭在學術上的價值

櫻花鉤吻鮭在學術上具有很珍貴的價值，這些價值大致可以歸納入以下諸點：

1．櫻花鉤吻鮭是冰河時期的遺留生物，也是臺灣目前唯一倖存的寒帶魚類，其存在證明位處亞熱帶的臺灣也曾有過寒冷時期，這種活標本」自有其歷史價值。

2．寒帶的魚類竟能生長在亞熱帶的臺灣高山溪流中，其存在乃是探

索生物進化過程的極佳題材。

3．櫻花鈎吻鮭與日本櫻鮭的比較報告，早在民國六年即由日人大島正滿提出，同時這是臺灣特、稀有動物中，最早公諸於國際的一篇報告。

4．全世界類似陸封性鮭鱒魚類並不多，只有日本、韓國及我國東北才有。櫻花鈎吻鮭的存在亦足以輔證或說明臺灣和大陸、日本、韓國之間在地理學上的密切關係。

5．日據時期日人曾將櫻花鈎吻鮭列爲天然紀念物予以保護（Nakamura, H. and Y. Koshigi 1938），除著有專書外，並擬有詳細的規劃管理辦法。而今日我們維護櫻花鈎吻鮭的繼續生存，也是具體實踐自然生態保育的重要方向之一。

6．臺灣是全球鮭、鱒類第二南限之分布地，櫻花鈎吻鮭在昔日即引起國際間自然生態學者的重視，因此深具學術價值。

六、目前政府正施予嚴格的保護以及進行族群的復育

基上所述，加上櫻花鈎吻鮭在古生物學、古地理學，古氣候學、地質學上的研究價值都非比尋常，是以爲臺灣生物中迫切需要加以保護者。有鑑於此，櫻花鈎吻鮭已於民國七十三年經政府依法列爲瀕臨滅絕的動物，嚴格加以保護。在方法上，不但全面禁止捕撈這些鮭魚，同時也設法復原先前受到人爲改變的棲所環境。在另外一方面，一項復育這些鮭魚的計畫也正在進行中，期使此鮭魚免遭滅絕之虞。

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REVIEW ON THE CURRENT STATUS OF AMPHIBIANS IN TAIWAN

Kuang-Yang Lue, Cheng-Yen Lin, Kuo-Shou Chuang and June-Shiang Lai

Abstract. The authors are trying to use a more sophiscated method to evaluate the distribution patterns & current species status of amphibians in Taiwan. The major information resources were come from the amphibian data base of the Department of Biology, NTNU.

A total of 7609 pieces of information and 303 recorded localities from the amphibian data base were analysized. The distribution patterns of Taiwan's amphibian can be separated into 4 patterns, based on the variation of existing in 5 district. i.e. (1) 5 species in the pattern of Restricted-distribution, (2) Regional-distribution species, with 4 species, (3) Widely-distribution species, with 7 species, and (4) 13 species in the pattern of Pan-distribution.

As for current status category (1) recorded localities under 5, under 0.4% of records and existing in one distince-Endanger species, total 2 species, (2) Vulnerable species, with recorded ocalities under 5, under 0.4% of records, and existing under three district, total 2 species, (3) Rare species, with recorded locality above 5, and above 0.4% of total records, the distribution is within 3, (4) Out of danger species, with 5-60 localities, under 4% of total records of existing under 5 district, total 15 species, (5) Out of danger & common species, with more than 60 recorded localities, above 4% of total records of existing in whole 5 district, total 6 species, (6) Insufficiently known species, only one species in this category. A detail discussion could be found in the report.

台灣產兩棲類現況評估

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中 文 摘 要

本報告是以台灣兩棲類的資料庫中所儲存10年來的7609筆的資料及 303 個的記錄地點爲依據，來對台灣現存的兩棲類的分布類型(distribution pattern) 和現況類型 (current species status) 進行科學上的分類。在分布類型中計可分爲 (1) 局部分布類型 (Restricted-distribution species)計有五種；(2)區域分布類型 (Regional-distribution species)：計有四種；(3)廣分布類型(Widely distribution species)：計有七種；(4)泛分布類型(Pan-distribution species)：計有十三種。而現況類型則有 (I)瀕臨絕種(Endangered species)記錄地點 5 以下，記錄筆數 0.4% 以下，僅分布一區者，有二種屬此類；(II) 受威脅種類 (Vulnerable species)記錄地點 5 個以上，記錄筆數0.4%以下，分布三區以上者，計有二種：(III) 稀有種(Rare species)記錄地點 5 個以上，記錄筆數0.4%以上，分布不超過三區者，計有三種；(IV)無危險種類(Out of danger species)記錄地點60個以內，記錄筆數 4%以下，分布五區以內者，計有十五種；（V）無危險且常見種(Out of danger & common species)記錄地點60個以上，記錄筆數 4%以上，五區皆分布者，計有六種（VI）未知現況種(Insufficiently known species)。這現況的檢討還有缺點，但是已足以做爲科學和保育上的參考。

一、緒言 (Introduction)

自從民國七十八年農業委員會公佈野生動物保育法（行政院農業委員會，1989）後，不僅是農業委員會本身，即使是學術界也經常會遇到執法機關或一般民眾所提出來的一些相關問題，例如何謂瀕臨絕種動物（Endangered species）？何謂稀有動物（Rare species)？有些什麼標準可以依循，以將各類動物依野生動物保育利用法規來定位？這些都是一些非常難回答的問題。不僅國內的專家學者和立法機關無法給一般民眾非常滿意的答覆，即使是世界上一些保育較先進的國家和相關的機構，也都無法給人一個非常明確的答覆。

依據國際自然保育聯盟（IUCN, International Union for Conservation of Nature）所出版的紅皮書（Red Data Book)（IUCN, 1981,1982,1983)，上面將世界上的生物依現況分別列陳了已滅絕（Extinct)、瀕臨絕種（Endangered)、易受傷害（Vulnerable)、稀有（Rare)、現況未定（Indeterminate)、無危機（Out of danger)、資料不足（Insufficiently known)、商業上受威脅(Commercially threatened）等八種類別，加上受威脅群聚（Threatened Community）和受威脅自然現象（Threatened phenomenon）等二類生物群聚，亦分別給與適當的定義。如果仔細來審視這些定義，絕大部份都僅限於文字上的敘述而缺少量化上的數據，因此都很難使人信服。雖然在植物現況的界定方面討論得比動物方面多，在國際自然保育聯盟IUCN Threatened Plants Committee Secretariat 所出版之 How to use the IUCN Red Data Book Categories 中所涉及的 Rare and Vulnerable species，有提到20000個體的數據，來當做一劃分的標準，但亦無詳細的說明。可以瞭解的是，有關"量化"之現況（Current status）是一個保育界必須要解決的問題。

在本島有關植物的現況檢討，蘇鴻傑在1980年的報告中曾討論336種，而賴明洲先生（1989）在一研討會中亦分別討論到現況的評估，但都沒有一個很明確的討論。至於有關本省動物方面的現況，尚

無任何有關較科學化的檢討和評估，這最主要的原因是動物資源方面的資料一直非常的缺少。筆者在過去十年中對於兩棲類方面收集了一些較詳細的資料，因此在此篇報告中，嚐試著以"量化"的方法，來將本省產的兩棲類的現況（Current status）界定出來，以喚起學術及保育界方面來多多探討這一方面的問題。

二、方法（Method）

本報告中有關本島兩棲類的現況界定，是以國立台灣師範大學生物學系在過去十年來，在野外進行調查和收集的資料所建立的資料庫（Data Bank）來進行運算和界定。在資料庫中目前已有7609筆的記錄，而記錄的地點已涵蓋了台灣各地的 303個地點（圖一），雖然涵蓋的地點仍不夠廣，但是儘量遍佈各地，故應已具代表性。至於台灣兩棲類的現況，以下分二部分來探討。

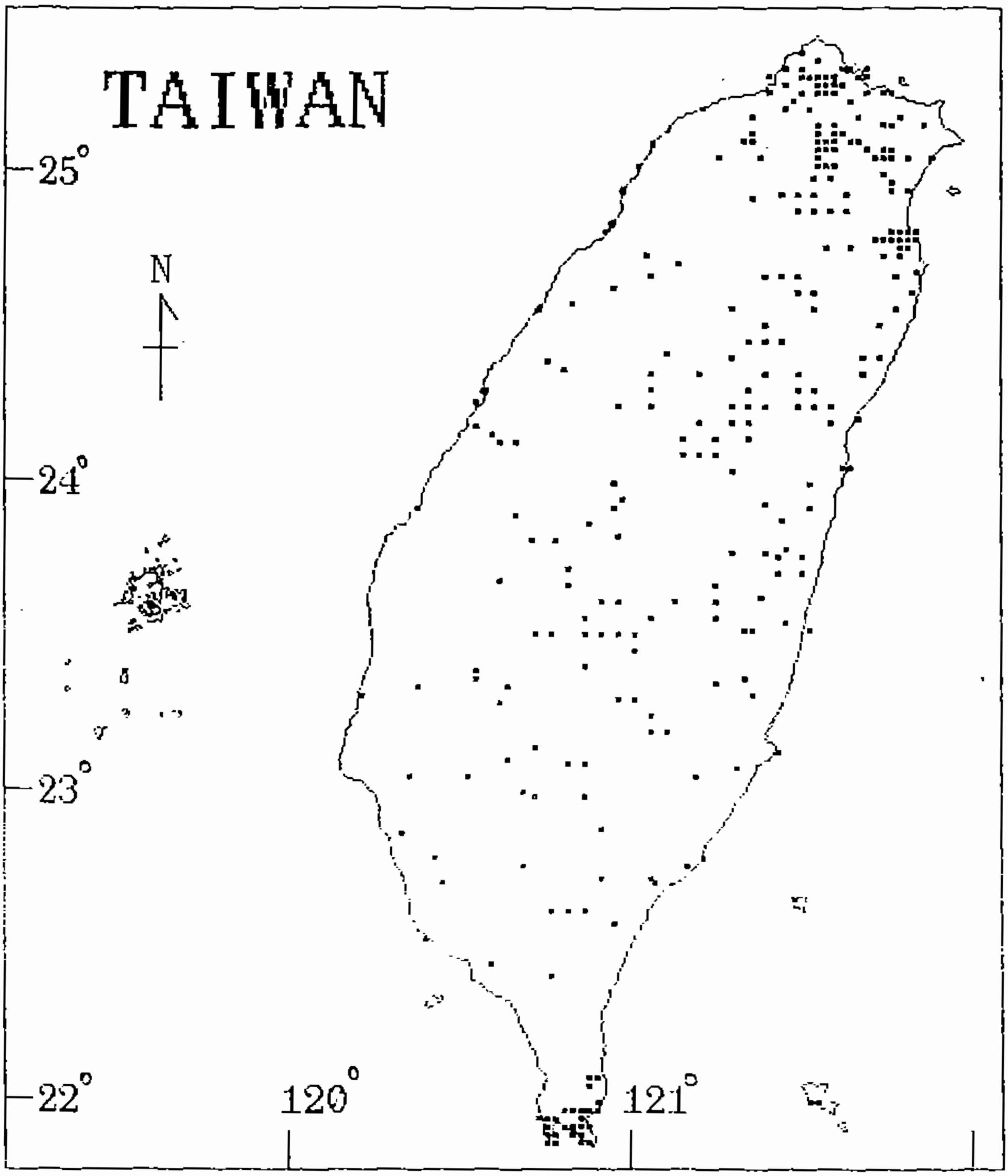
(一)分布類型（Distribution pattern），分(1).局部分布類型（Restricted-distribution species）、(2).區域分布類型（Regional-distribution species）、(3).廣分布類型（Wildely-distribution species）、(4).泛分布類型（Pan-distribution species）等四類，分別依各種（ Species）在北區、中區、南區、東區和山區等五區中分佈有無來定，至於這五區的範圍如下：（圖二）

(a).北區（Northern District）：以大安溪以北及東部宜蘭縣的平地到低海拔的地區。

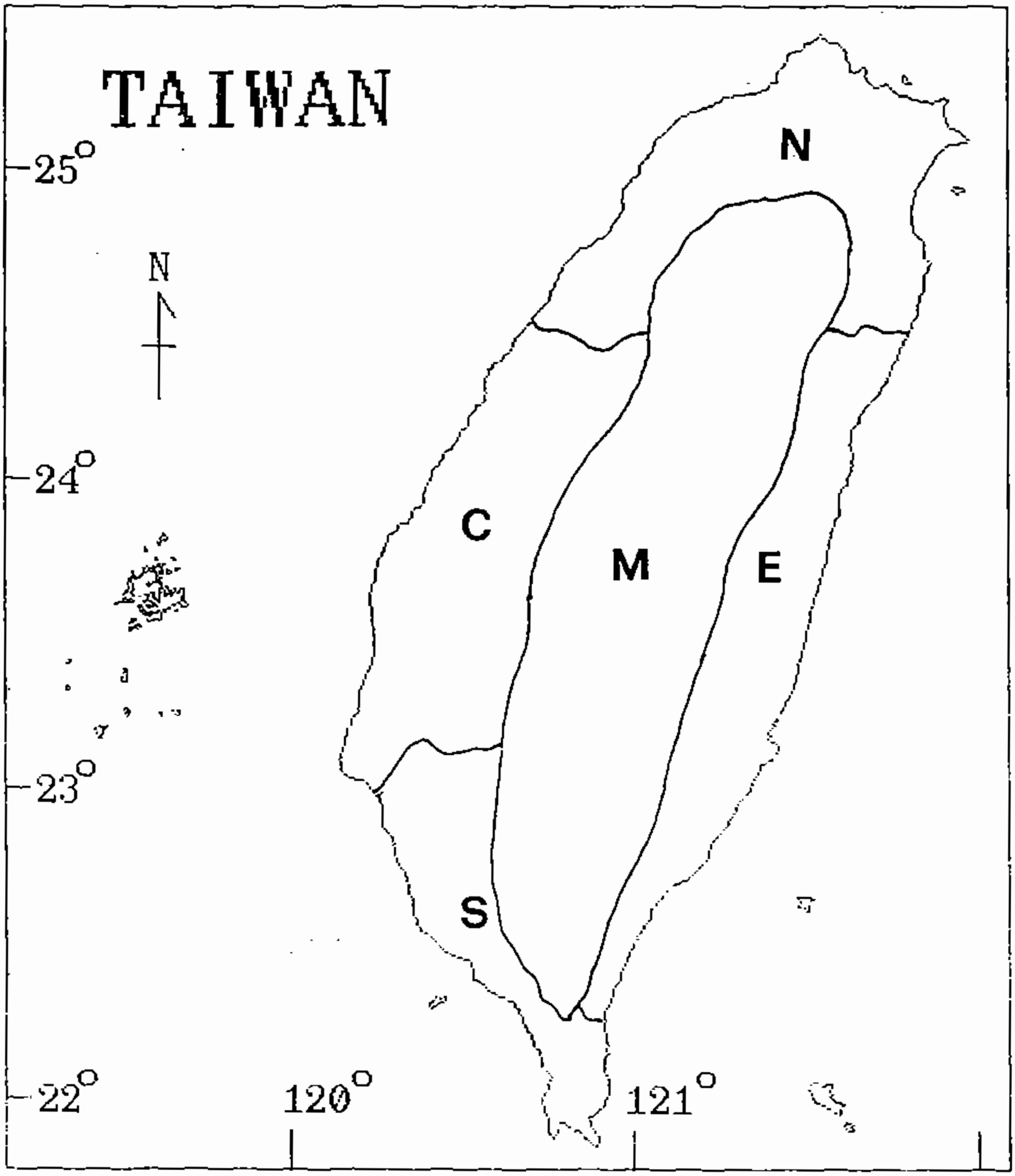
(b).中區（Central District）：在本島西部，大安溪以南到曾文溪以北的範圍。

(c).南區（Southern District）：在本島西部曾文溪以南一直到墾丁，包括澎湖群島。

(d).東區（Eastern District）：在本島的東海岸和平溪以南至大武溪以北，以花蓮和台東兩縣為主。



圖一　已有紀錄地點分布圖



圖二　地理分區圖示　N：北區　C：中區　S：南區　E：東區
M：山脈區

(e).山脈區（Mountain District）：指本島中部，海拔在500 公尺以上的山區。

(二)現況類型（Current species status）：有關的類型分爲下列六類：

(1).瀕臨滅絕種（Endangered species）(E)

(2).受威脅種（Vulnerable species）(V)

(3).稀有種（Rare species）(R)

(4).無危險種（Out of danger species）(O)

(5).無危險且常見種（Out of danger and common species）(OC)

(6).資料不足種（Insufficiently known）(K)

現況類型考慮的因素有(a).此種佔目前記錄地點次數的多寡、(b).該種佔所有資料庫之百分比、(c).該種目前在台灣分布區域的多寡。

三、結果和討論（Result and Discussion）

藉著上面敘述的方法，台灣產兩棲類的分布現況如表一。在地理分布類型方面有：

(a).局部分布種（Restricted-distribution species）：這些種類，牠們僅分布在五個區域中的一個區域而已。計有台北赤蛙（Rana taipehensis）、巴氏小雨蛙（Microhyla buteri）和三種型態的山椒魚（Hynobius spp.）（圖三、四、五、六、七）佔台灣兩棲類約17.2%。

(b).區域性分布種（Regional-distribution species)：這些種類分布在本島五個區域之 2-3個區域中，計有台北樹蛙（Rhacophorus taipeianus）、翡翠樹蛙（Rhacophorus smarag-

表一、臺灣兩棲類分布及現況分析表

種類代碼 SP. NO.	紀錄地點	紀錄筆數 (%)	地理分布 北區	中區	南區	東區	山脈區	類型	現況
10	80	3.00	v	v	v	v	v	P	O
11	138	13.23	v	v	v	v	v	P	O*
12	42	1.91	v	v	v		v	W	O
13	48	3.35	v	v			v	R	O
14	4	0.34	v				v	R	K
15	62	3.90	v	v	v	v	v	P	O
16	53	3.90	v	v	v	v	v	P	O
17	69	5.52	v	v	v	v	v	P	O*
18	70	4.84	v	v	v	v	v	P	O*
19	52	3.26	v	v	v	v	v	P	O
20	36	2.85	v	v		v	v	W	O
21	22	1.76		v	v	v	v	W	O
22	2	0.21		v				S	E
23	6	0.43		v	v			R	R
24	86	4.77	v	v	v	v	v	P	O*
25	41	2.30	v	v	v	v	v	P	O
26	48	1.42	v	v	v	v	v	P	O
27	154	12.29	v	v	v	v	v	P	O*
28	84	7.81	v		v	v	v	W	O
30	7	0.26	v		v	v	v	W	V
31	7	0.12	v					S	V
32	30	2.29	v	v			v	R	O
33	49	2.69	v	v	v		v	W	O
34	20	1.10	v		v	v	v	W	O
35	54	2.67	v	v	v	v	v	P	O
36	92	10.49	v	v	v	v	v	P	O*
50	13	1.13					v	S	R
51	6	0.79					v	S	R
52	5	0.20					v	S	E

(1)種類代碼；

(10)黑眶蟾蜍(Bufo melanostictus), (11)盤古蟾蜍(Bufo gargarizans); (12)中國樹蟾(Hyla chinensis)

(13)台北樹蛙(Rhacophorus taipeianus)；(14)翡翠樹蛙(Rhacophorus smaragdinus)；(15)莫氏樹蛙(Rhacophorus moltrechti)

(16)白頷樹蛙(Polypedates megacephalus)；(17)褐樹蛙(Buergeria robustus)；(18)日本樹蛙(Buergeria japonicus)

(19)艾氏樹蛙(Chirixalus eiffingeri)；(20)面天樹蛙(Chirixalus idiootocus)； (21)黑蒙西氏小雨蛙(Microhyla heymonsi)

(22)巴氏小雨蛙(Microhyla butleri) (23)史氏小雨蛙(Microhyla inornata)；(24)小雨蛙(Microhyla ornata)

(25)古氏赤蛙(Rana kuhlii) (26)虎皮蛙(Rana tigrina rugulosa)；(27)澤蛙(Rana limnocharis)

(28)斯文豪氏赤蛙(Rana narina swinhoana)； (30)金線蛙(Rana plancyi)； (31)台北赤蛙(Rana taipehensis)

(32)長腳赤蛙(Rana longicrus)；(33)梭德氏赤蛙(Rana sauteri)； (34)腹斑蛙(Rana adenopleura)；

(35)貢德氏赤蛙(Rana guentheri)；(36)拉都希氏赤蛙(Rana latouchii)； (50)阿里山型山椒魚(Hynobius sp.)

(51)觀高型山椒魚(Hynobius sp.)， (52)南湖型山椒魚(Hynobius sp.)

(2)分布類型：

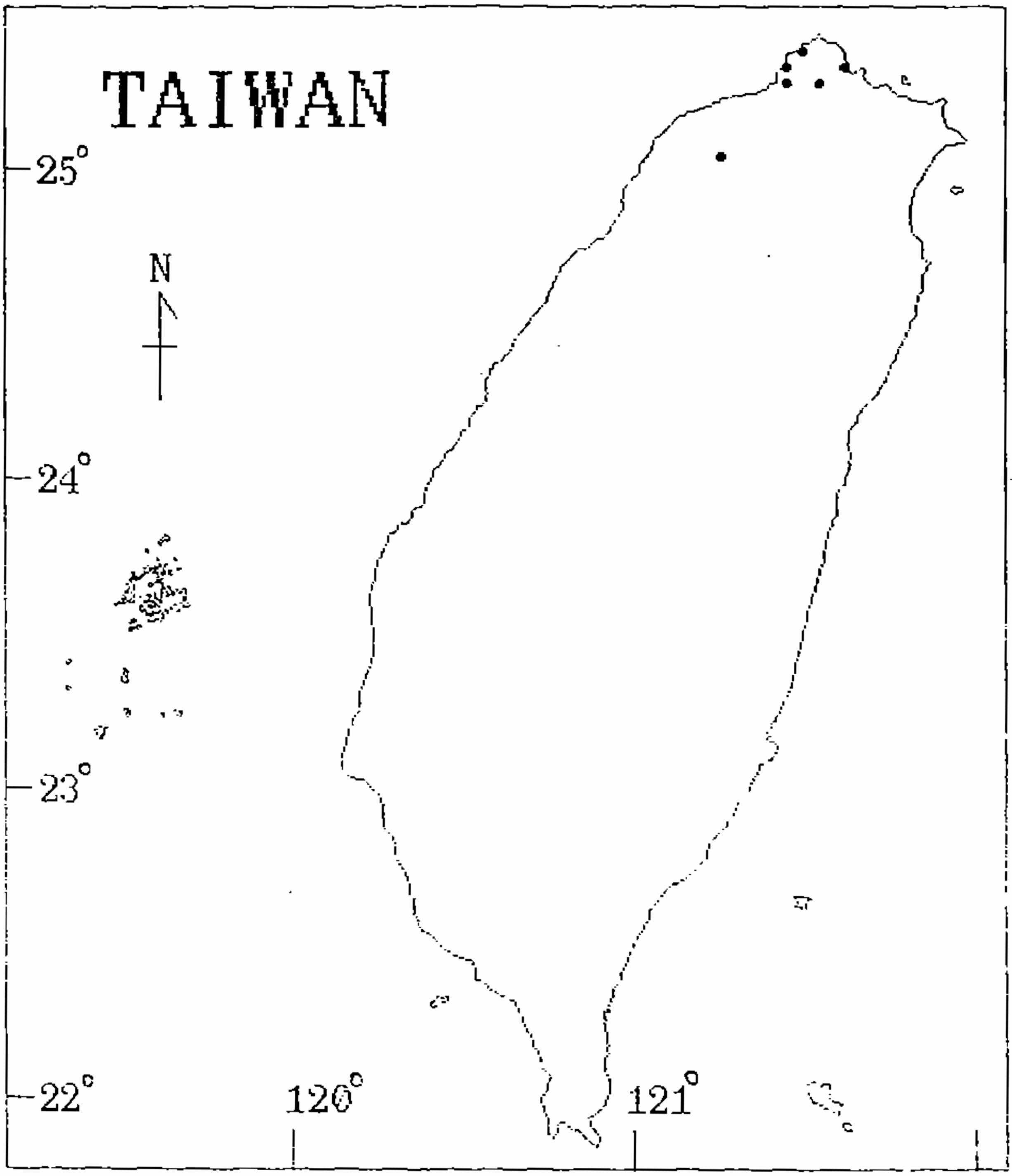
S:局部分布類型；R:區域分布類型；W:廣分布類型；P:泛分布類型

(3)現況類型：

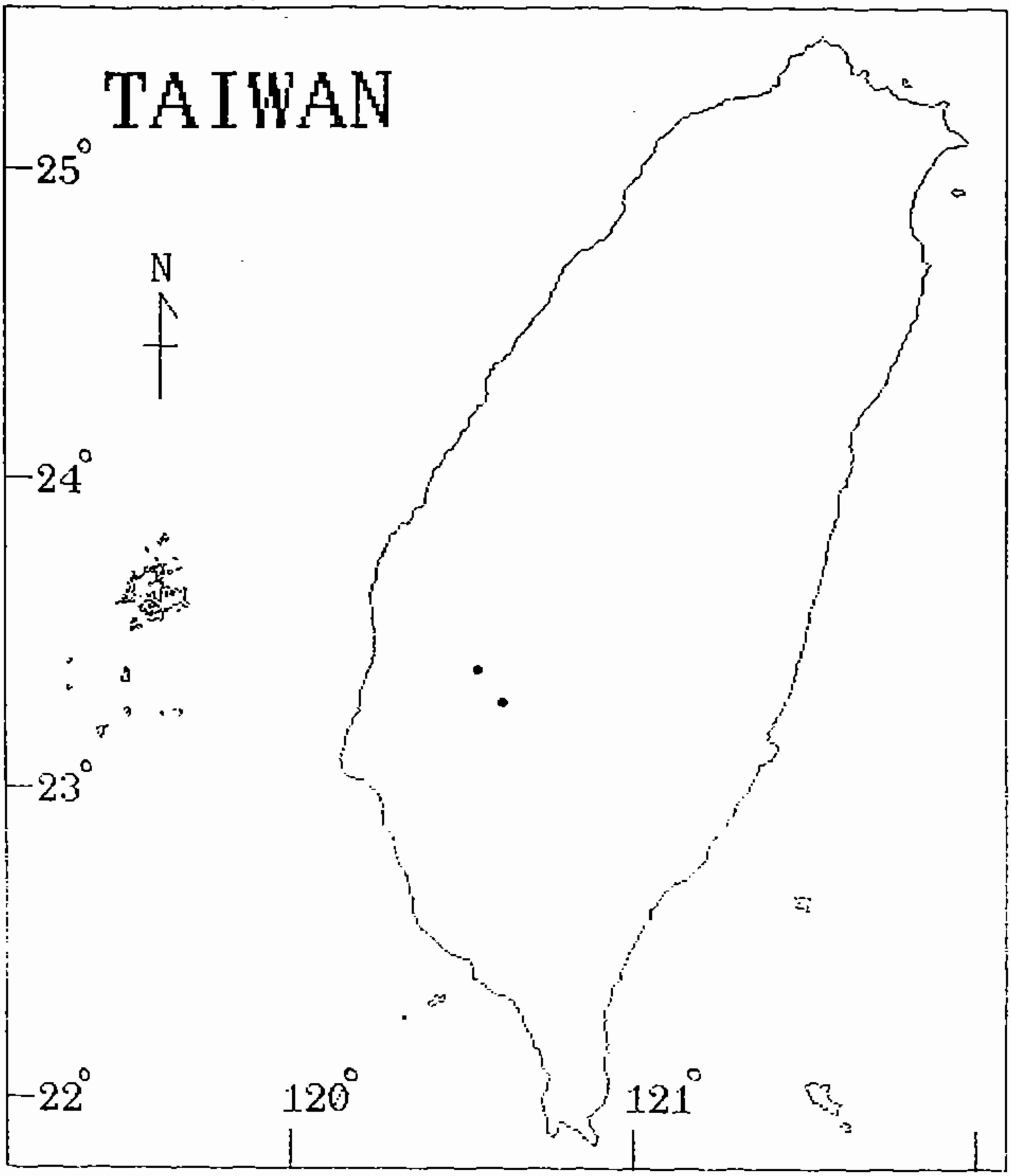
E:瀕臨絕種；V:受威脅種類；R:稀有種；O:無危險種類；O*:無危險且常見種

K:未知現況種

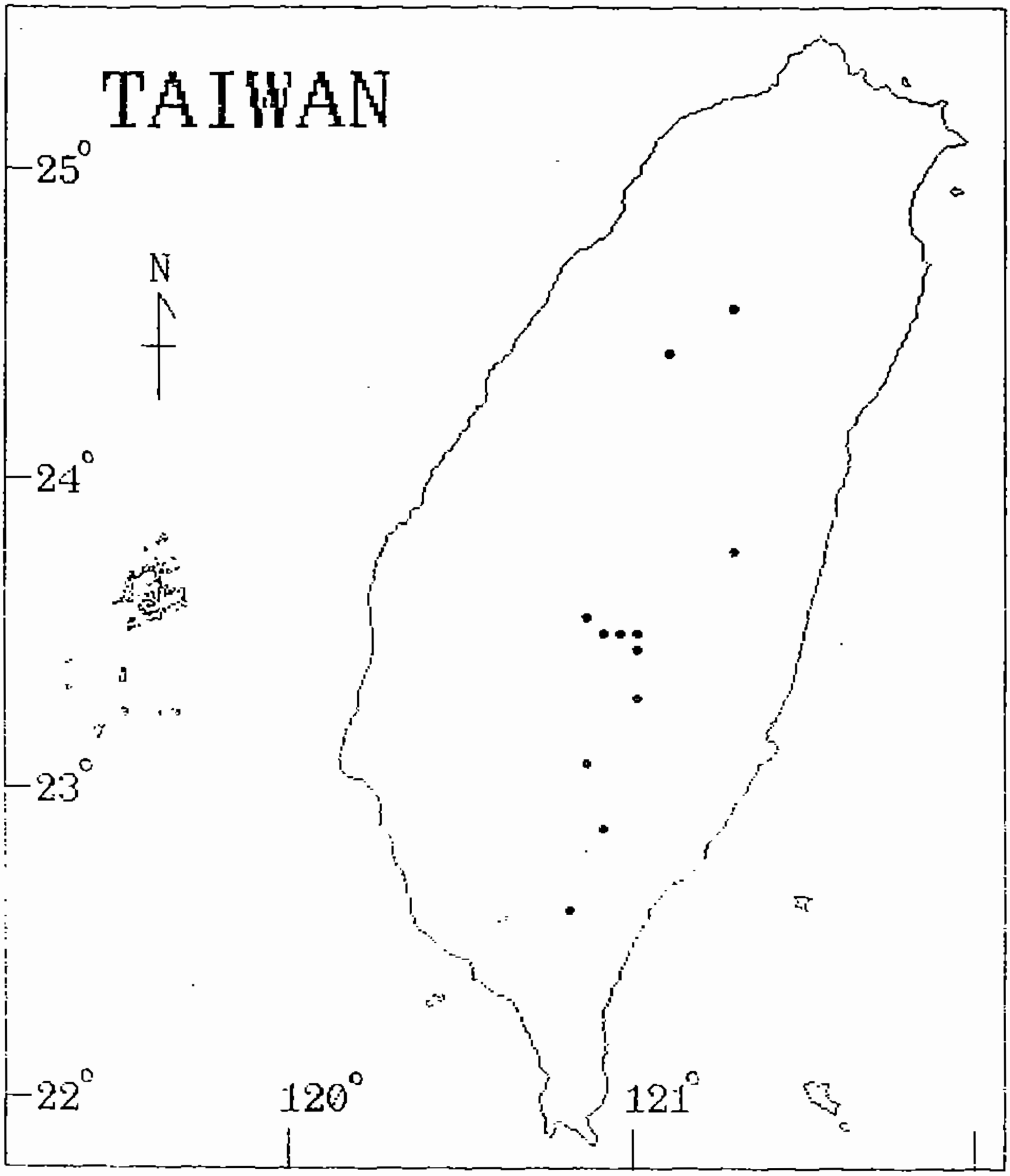
N:北區；C:中區；S:南區；E:東區；M:山脈區



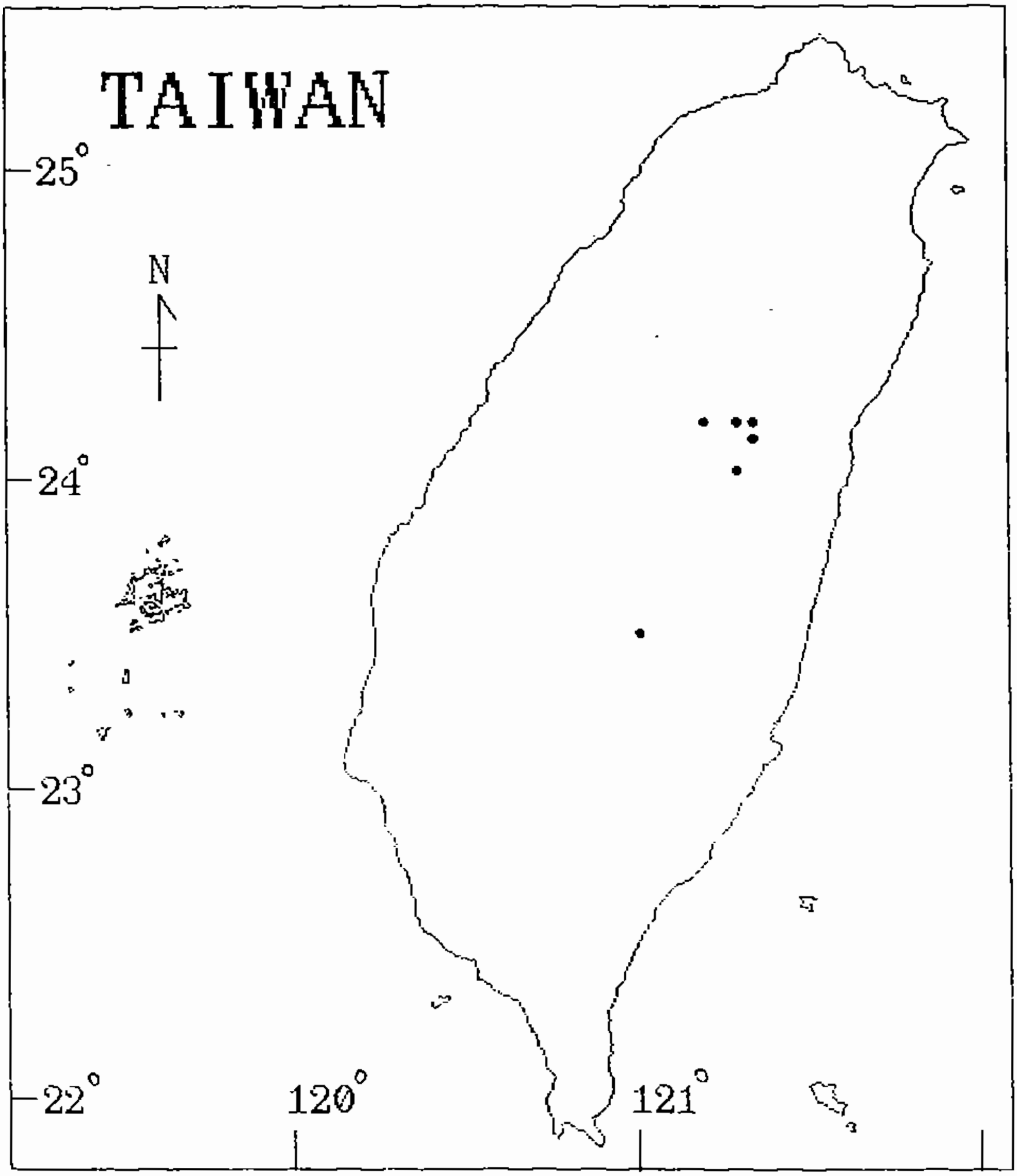
圖三　台北赤蛙（Rana taipehensis）紀錄地點圖示



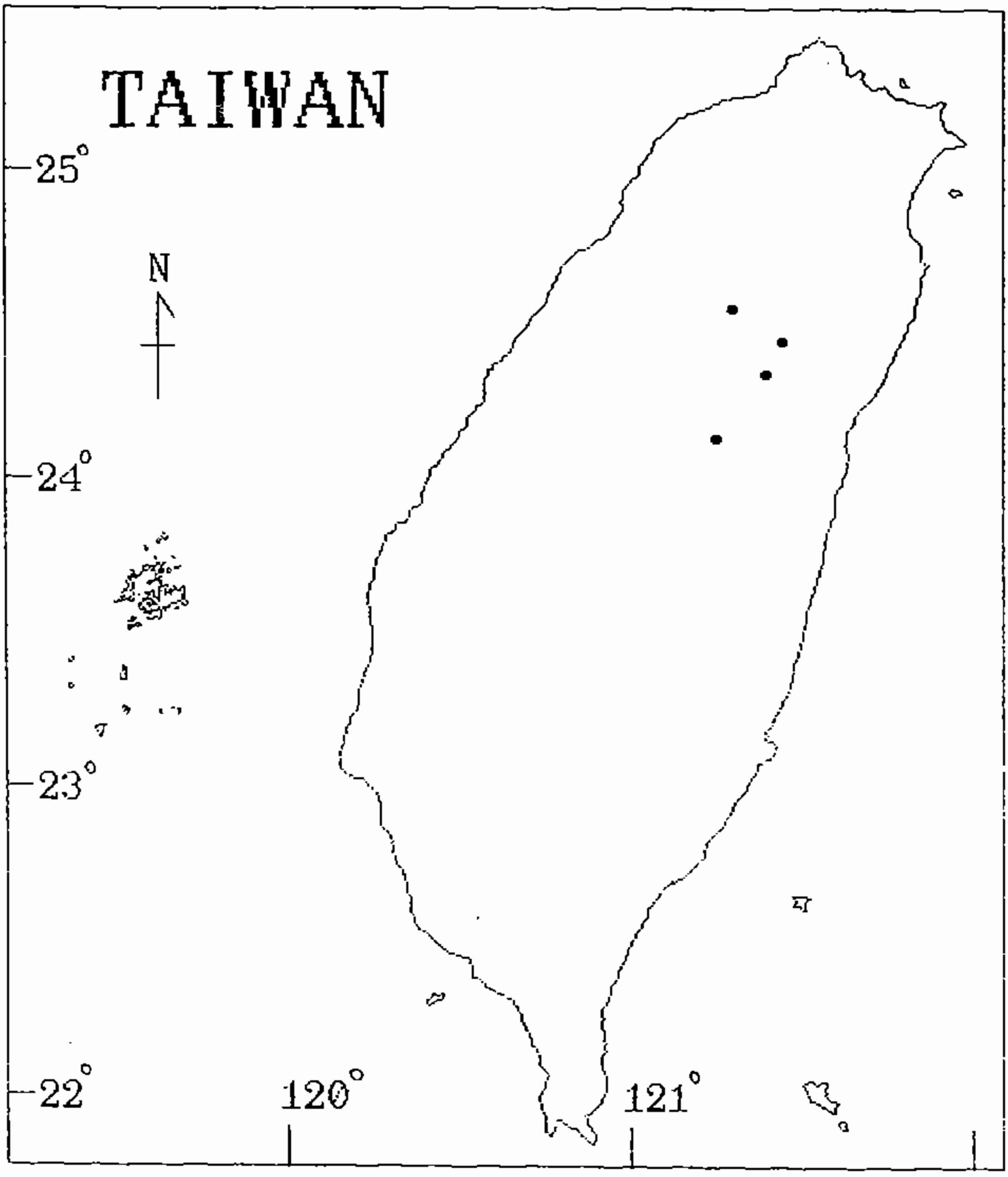
圖四　巴氏小雨蛙（Microhyla bulteri）紀錄地點圖示



圖五　阿里山型山椒魚（Hynobius sp.）紀錄地點圖示



圖六　能高型山椒魚(Hynobius sp.)紀錄地點圖示



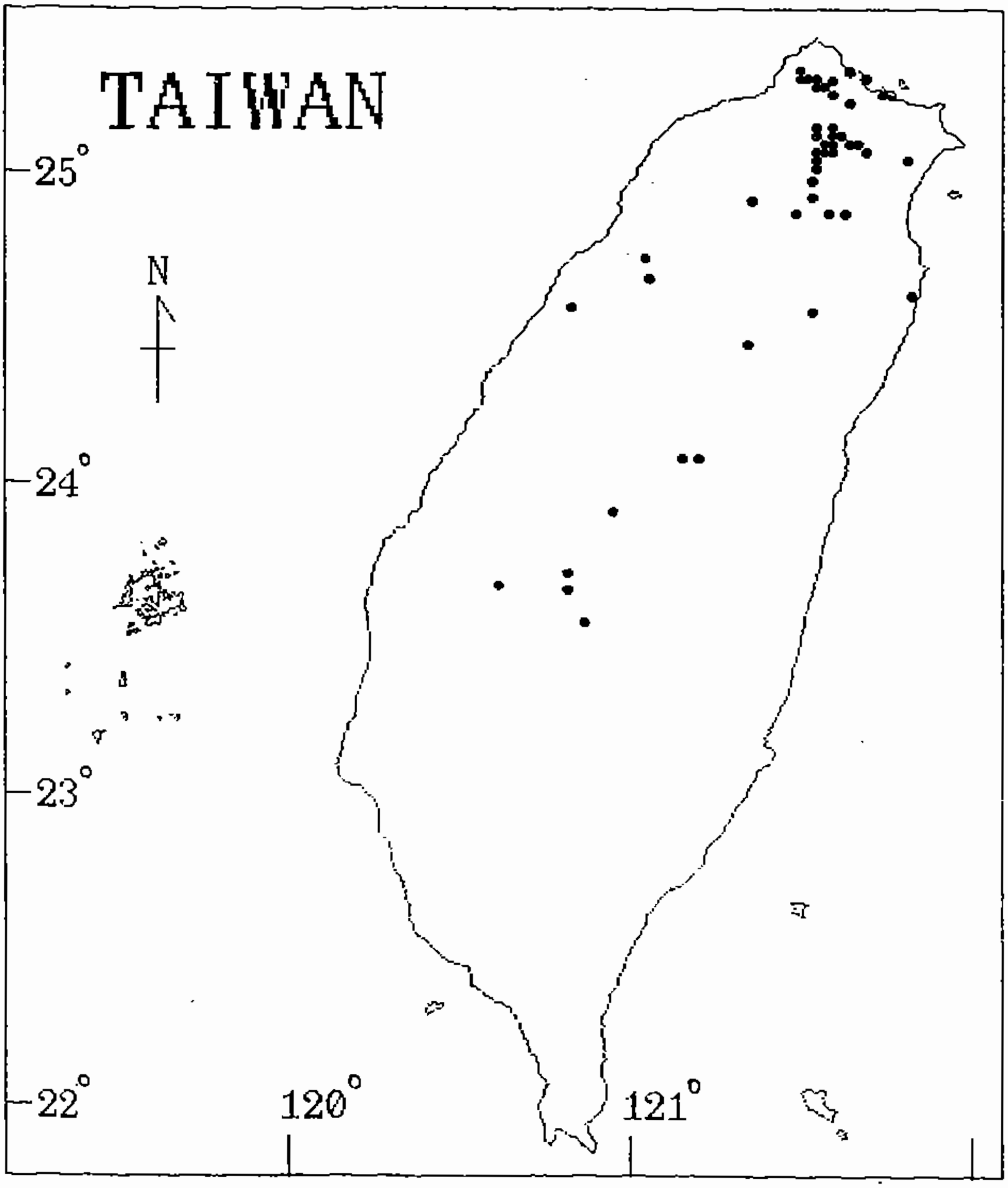
圖七　南湖型山椒魚 (Hynobius sp.) 紀錄地點圖示

dinus）、史氏小雨蛙（Microhyla inornata）和長腳赤蛙（Rana longicrus）（圖八、九、十、十一），佔台灣兩棲類約 13.8%

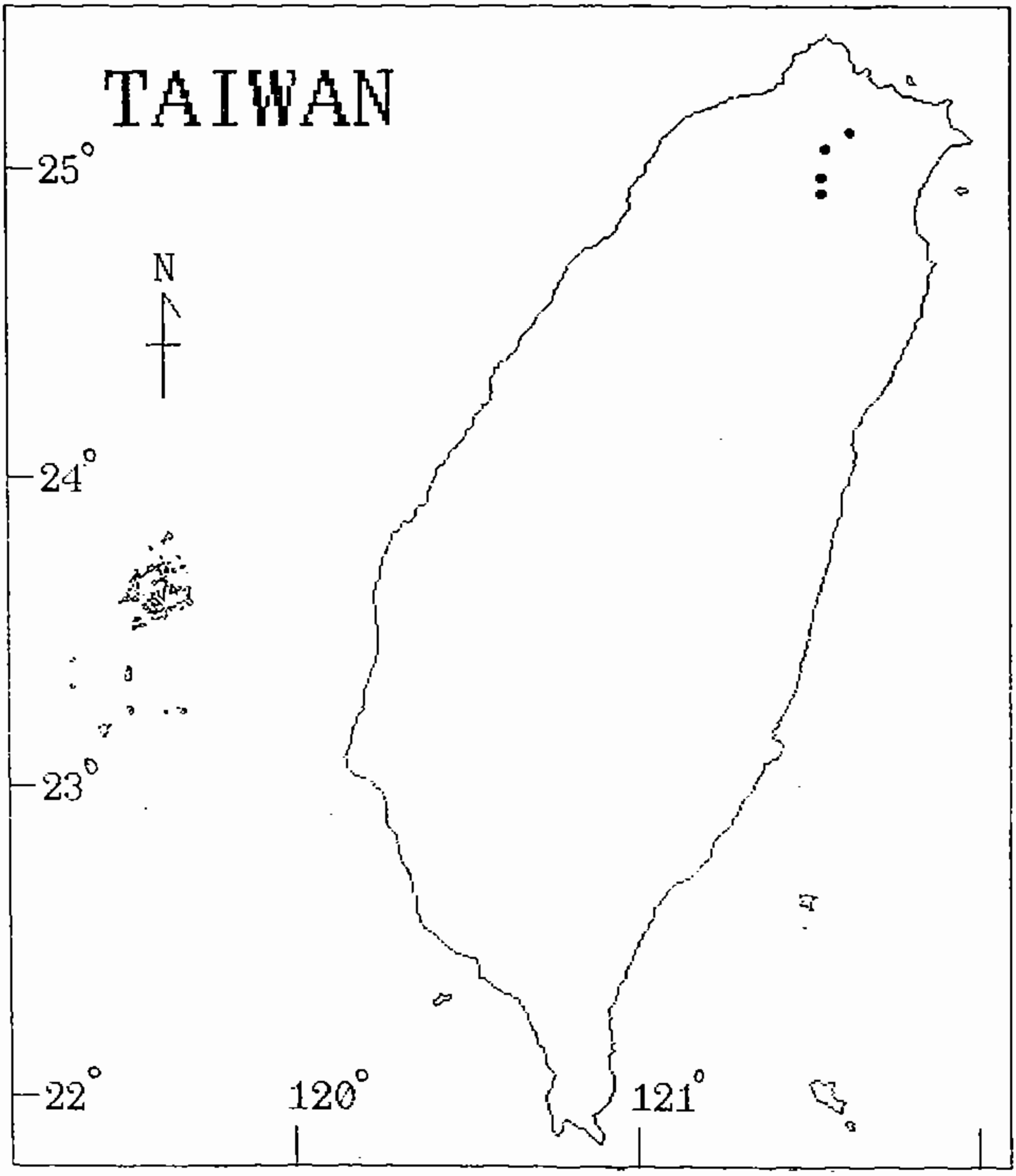
(c).廣分布種（Widely-distribution species）：這些種類分布在本島五個區域中之四個區域中，計有中國樹蟾（Hyla chinensis）、面天樹蛙（Chirixalus idiootocus）、黑氏小雨蛙(Microhyla heymonsi)、斯文豪氏蛙(Rana narina swinhoana)、金線蛙 (Rana plancyi)、梭德氏蛙（Rana sauteri）和腹斑蛙（Rana adenopleura）等七種（圖十二、十三、十四、十五、十六、十七、十八），佔台灣兩棲類約 24.1%。

(d).泛分布種（Pan-distribution species）：這些種類在東、北、南、中及山區等都有分布，計有黑眶蟾蜍（Bufo melanosticus）、盤古蟾蜍（Bufo gargarizans）、莫氏樹蛙(Rhacophorus moltrechti)、白頷樹蛙（Polypedates megacephalus）、褐樹蛙（Buergeria robustus）、日本樹蛙（Buergeria japonicus）、艾氏樹蛙（Chirixalus eiffingeri）、小雨蛙（Microhyla ornata）、古氏赤蛙（Rana kuhlii）、虎皮蛙（Rana tigrina rugulosa）、澤蛙（Rana limnocharis）、貢德氏蛙（Rana guntheri）和拉都希蛙（Rana latouchii）等13種（圖十九、廿、廿一、廿二、廿三、廿四、廿五、廿六、廿七、廿八、廿九、卅、卅一），佔台灣兩棲類之44.8%。

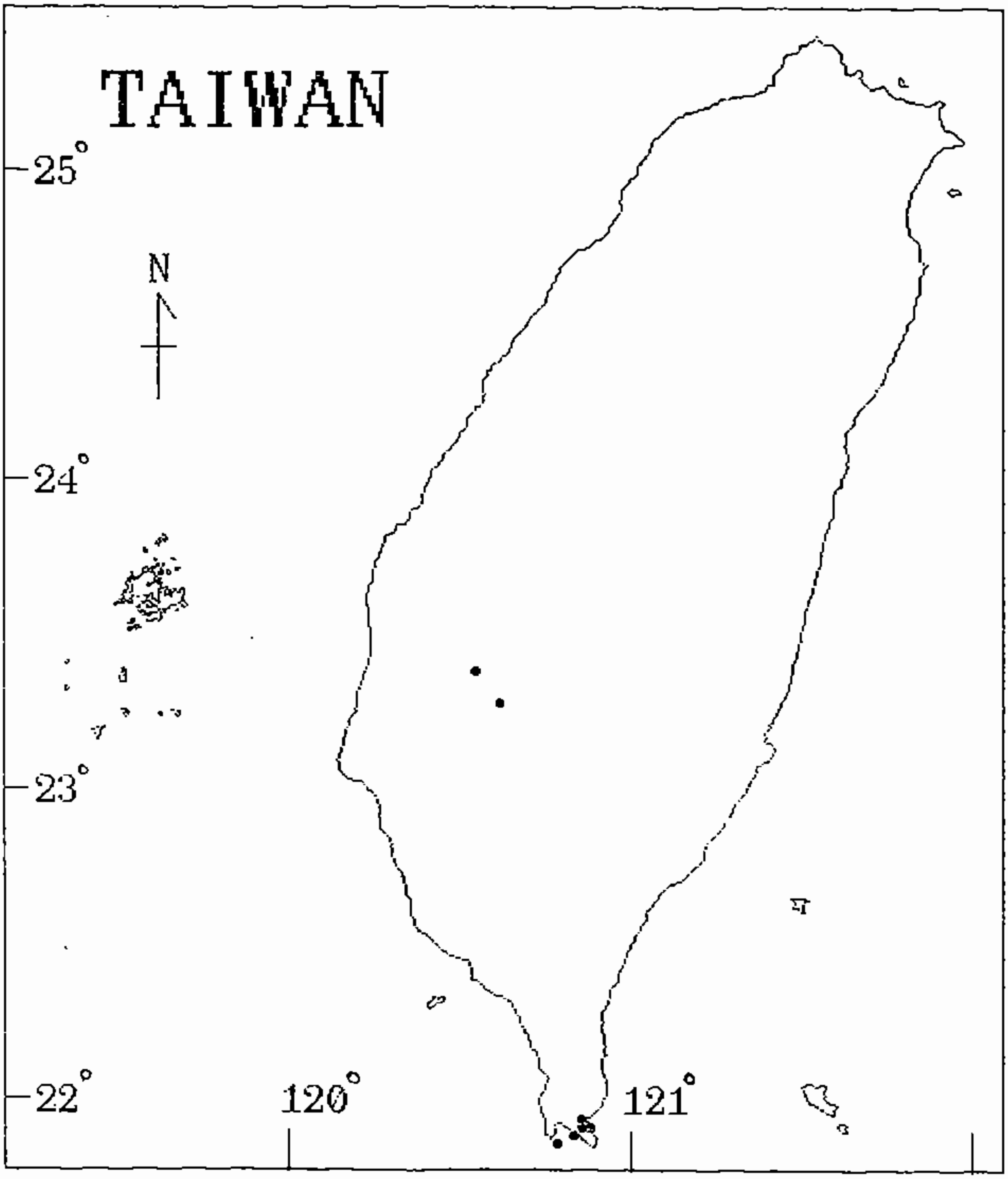
在上述的五個分布區（北、中、南、東和山區），每個區域大略約佔全島面積的 1/5。從地質學上來看，東部之花、東兩縣和其他各地區的形成原因有極大的不同；而從氣候學上來看，西部的大安溪是一個很重要的地理界限，在此以北的氣候和中、南部有極有的不同。而海拔 500公尺以下的山區，受人爲的干擾已有相當長的一段時間，而 500公尺以上的區域受人爲干擾的歷史還不算很長久，故原來兩棲類動物相的分布可能還沒有受到極大的影響。雖然在7609筆的調查記錄中，調查的記錄頻度和調查地點沒有很平均的分在五個區域（北區



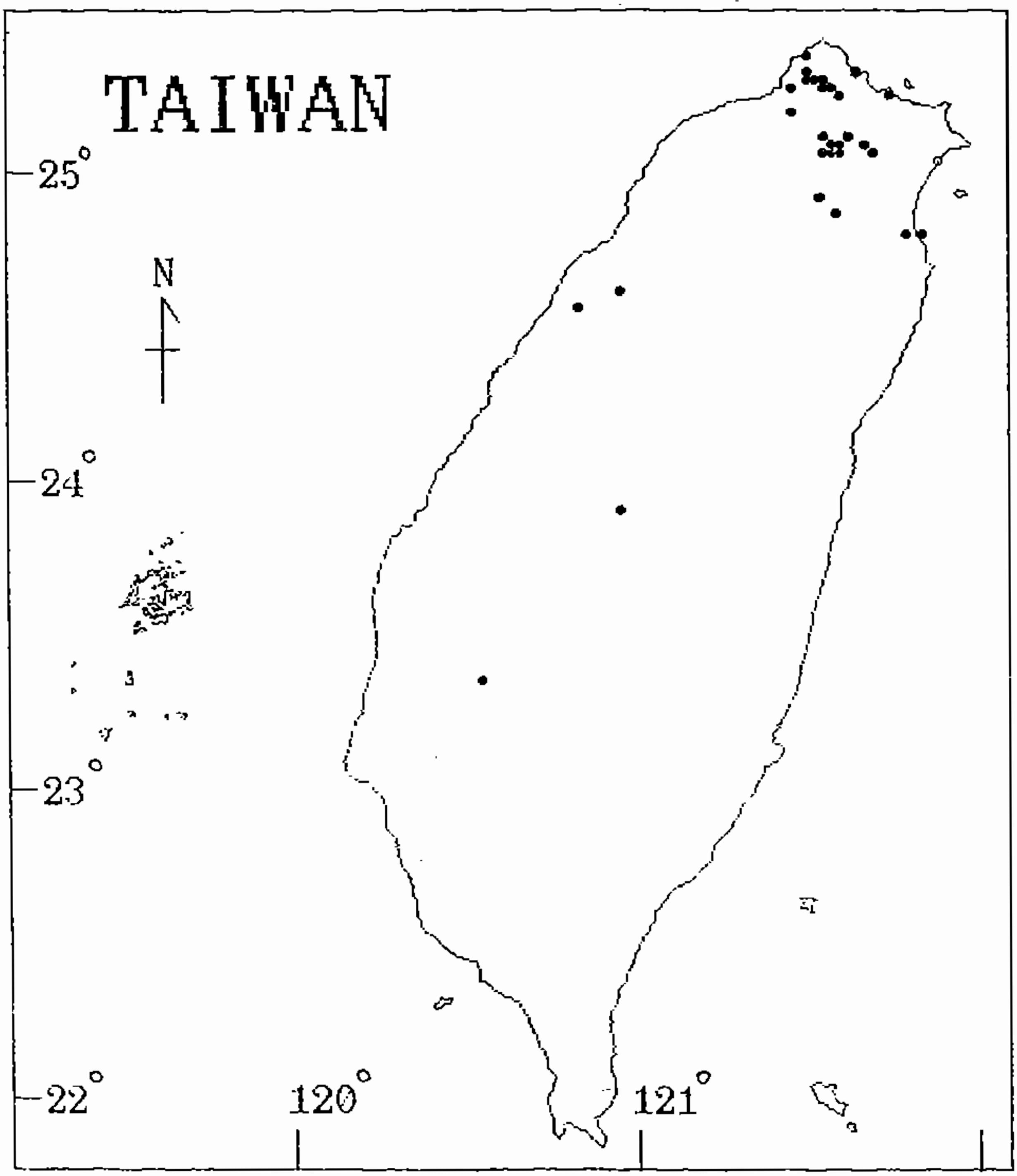
圖八　台北樹蛙（Rhacophorus taipeianus）紀錄地點圖示



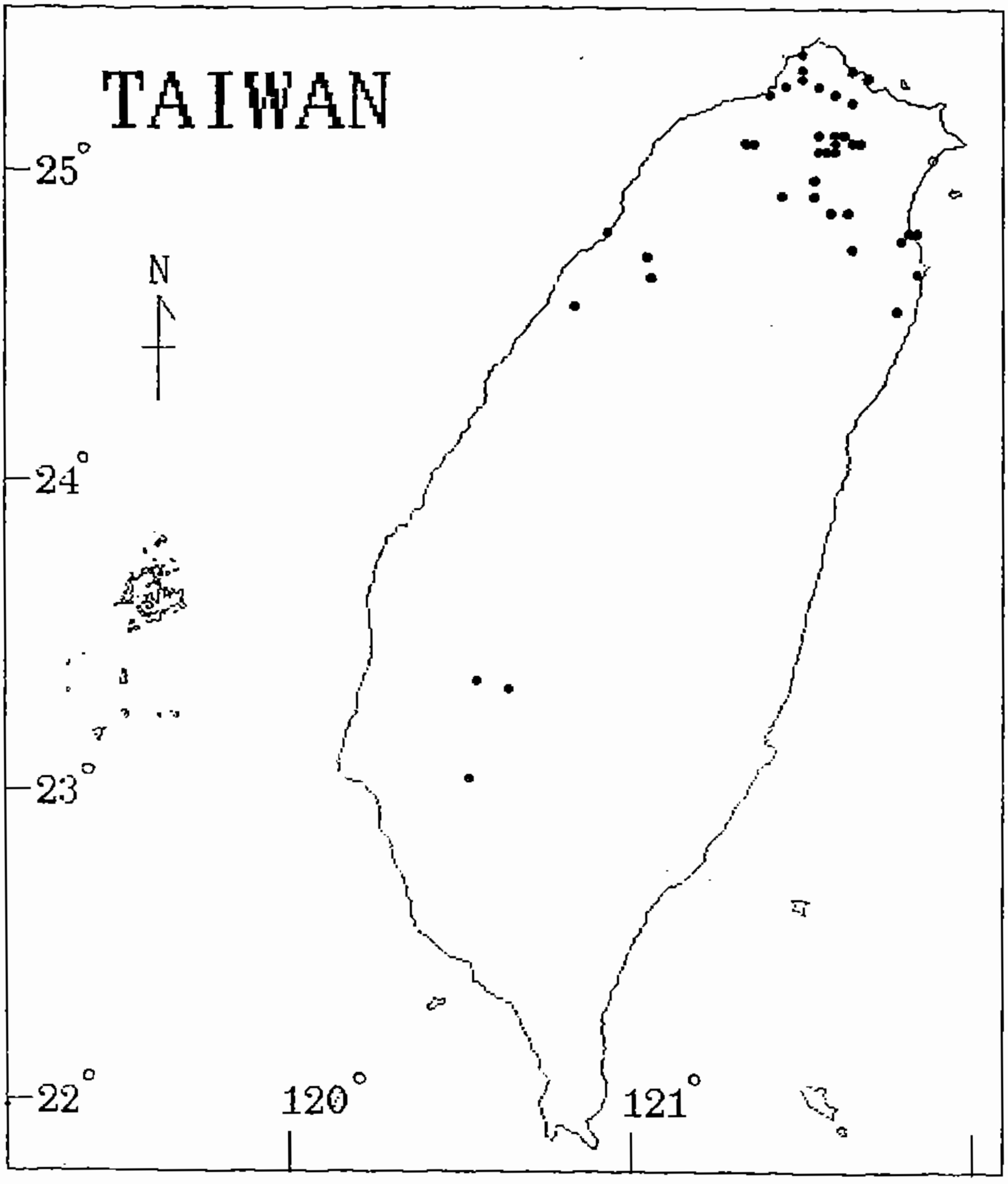
圖九　翡翠樹蛙（Rhacophorus smaragdinus）紀錄地點圖示



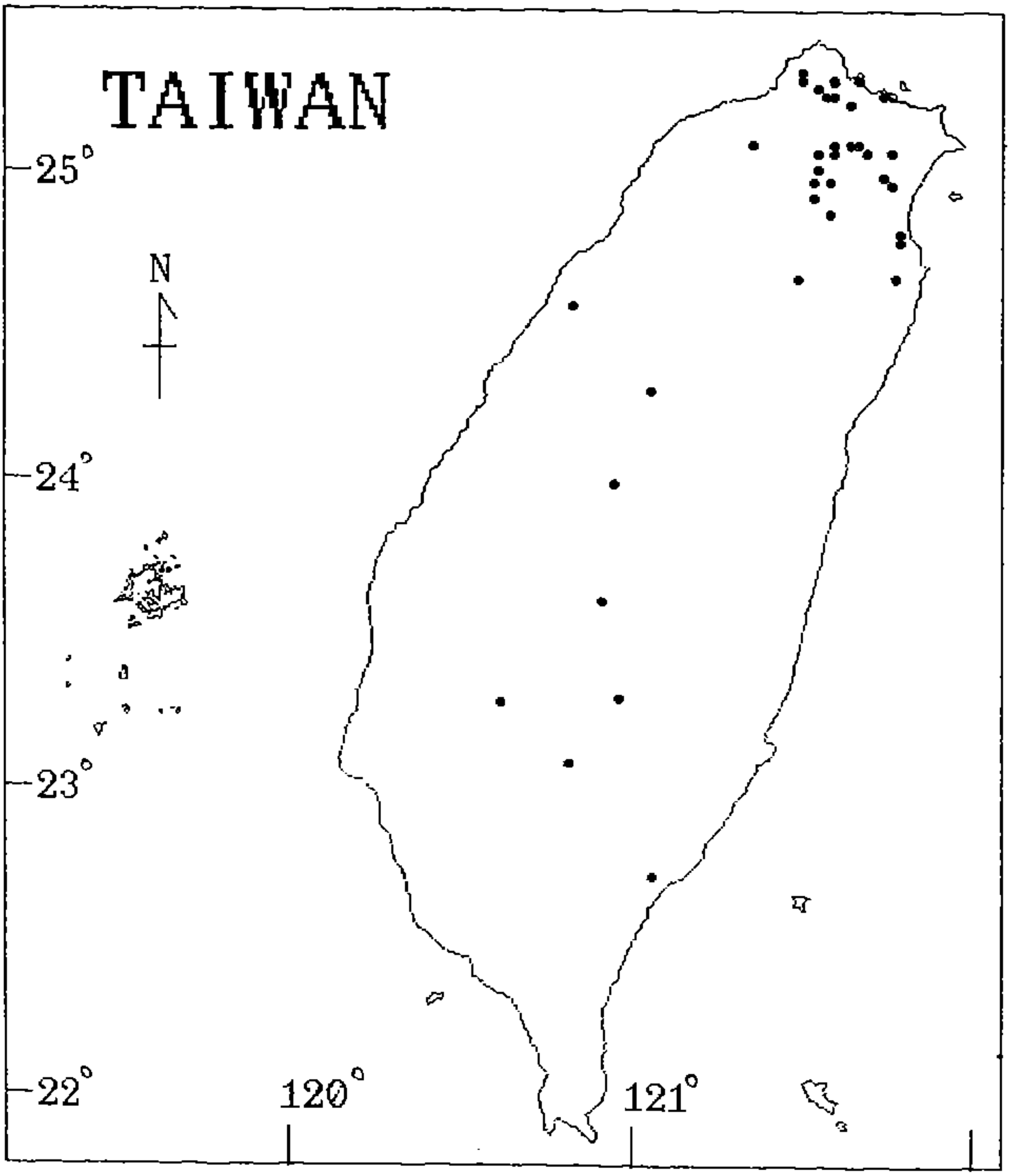
圖十　史氏小雨樹蛙（Microhyla inornata）紀錄地點圖示



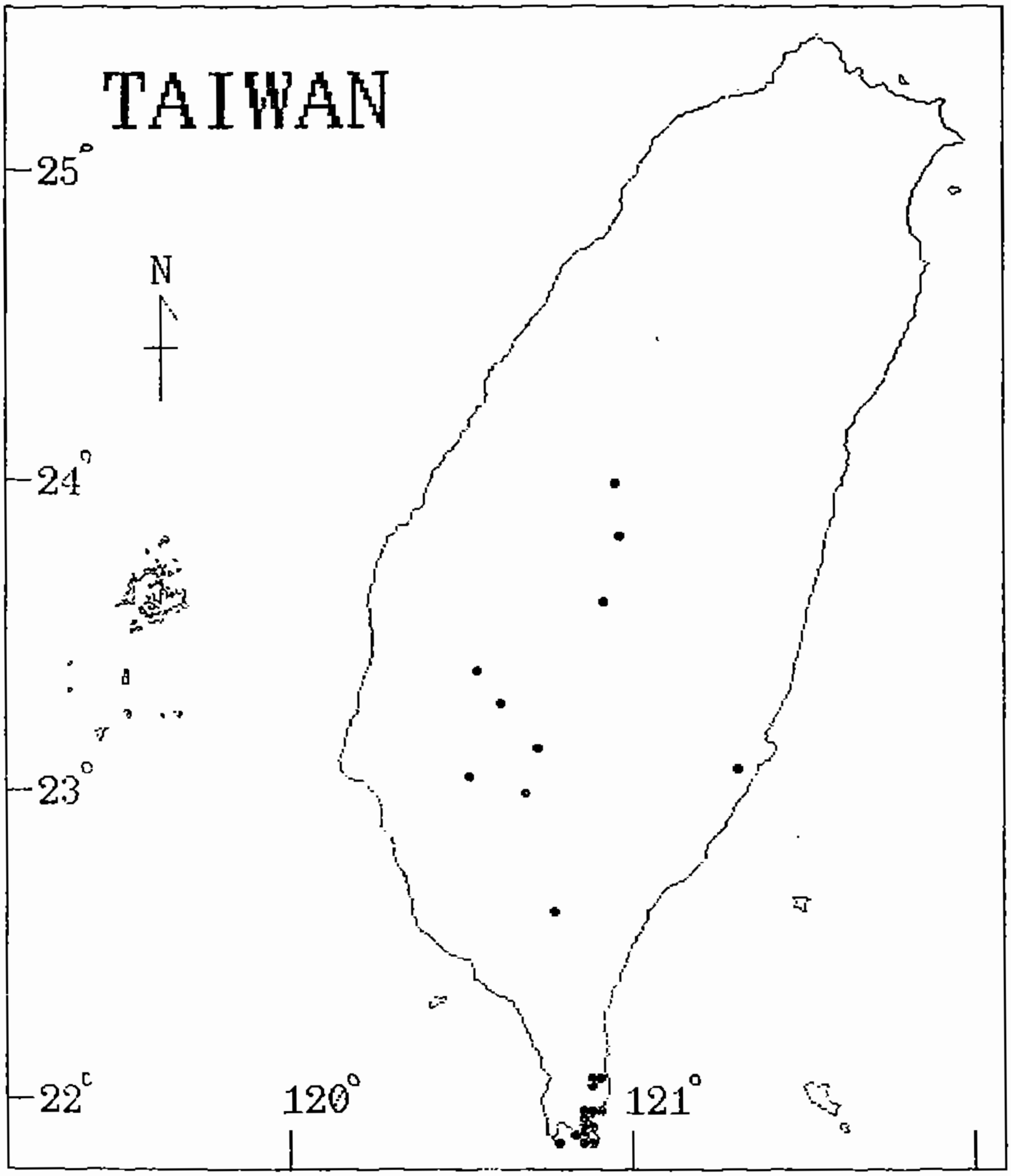
圖十一　長腳赤蛙（Rana longicrus）紀錄地點圖示



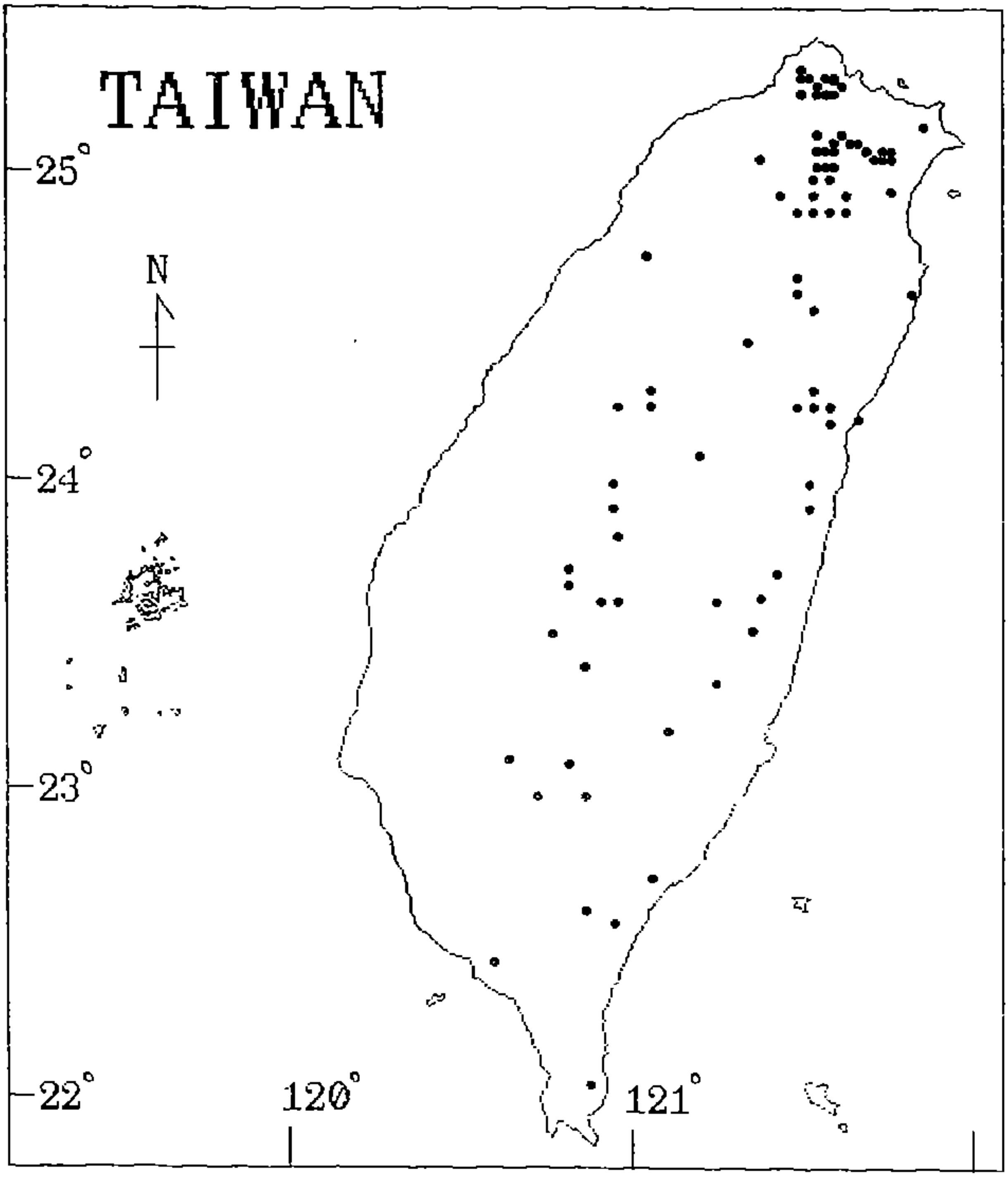
圖十二　中國樹蟾（Hyla chinensis）紀錄地點圖示



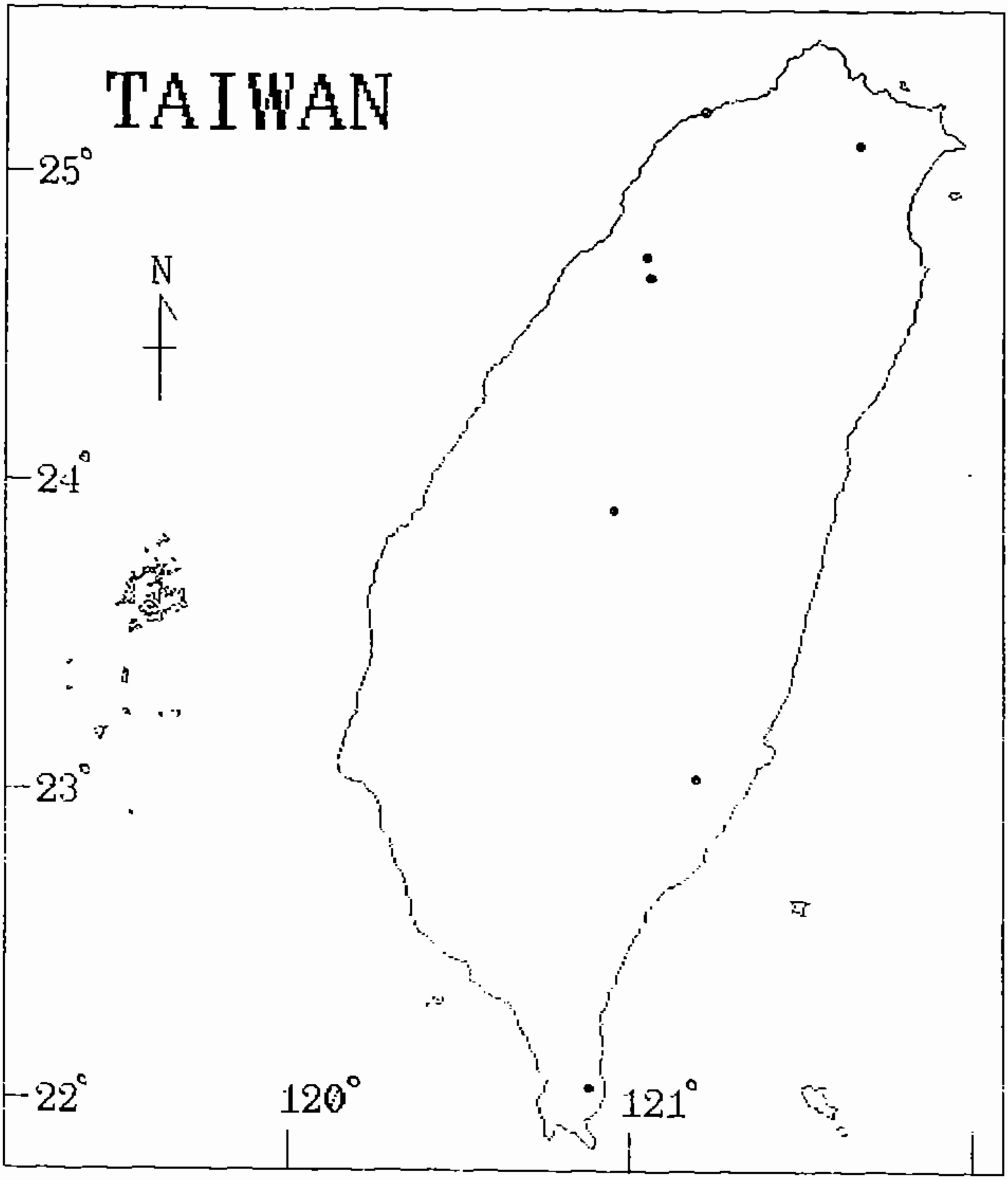
圖十三　面天樹蛙（Chirixalus idiootocus）紀錄地點圖示



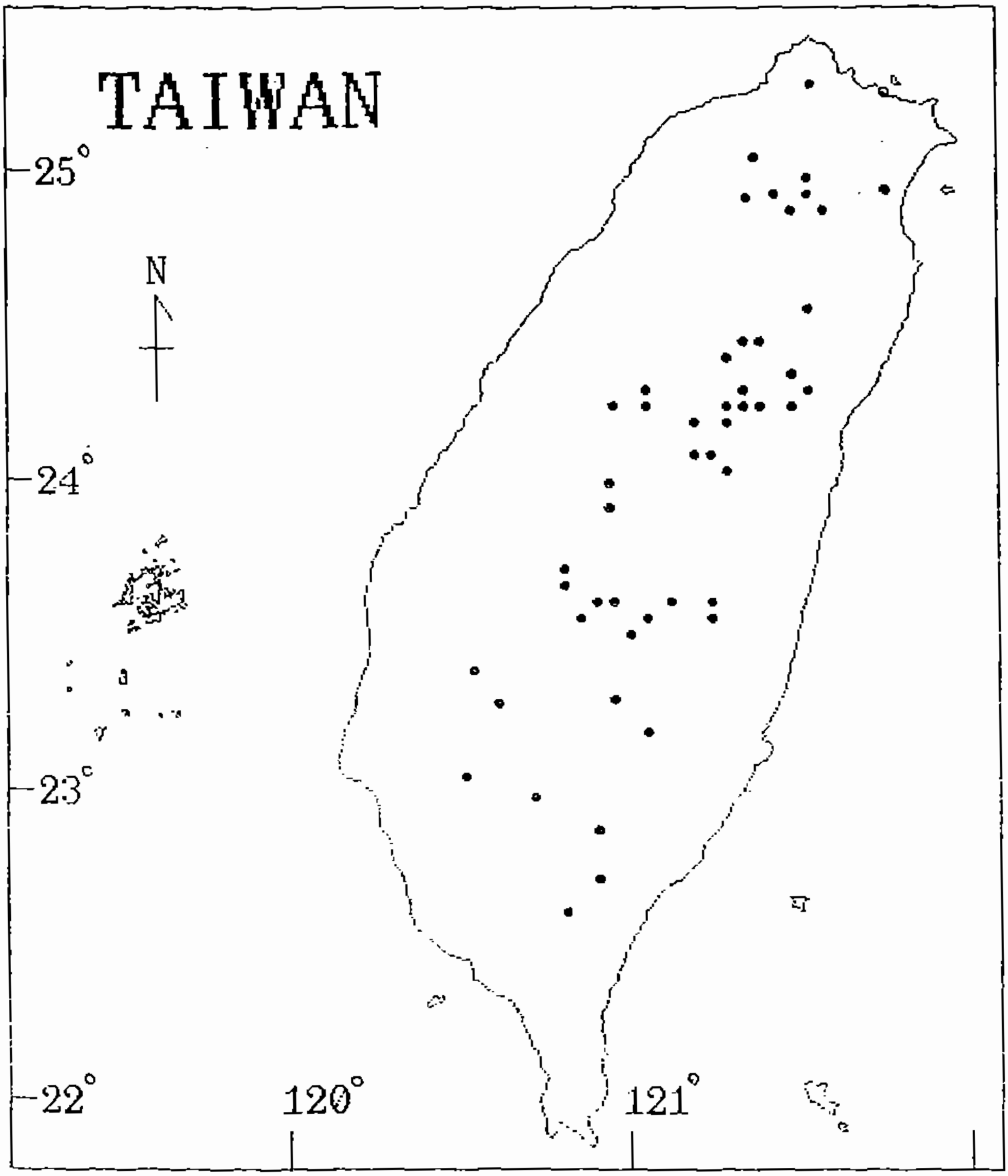
圖十四　黑氏小雨蛙（Microhyla heymonsi）紀錄地點圖示



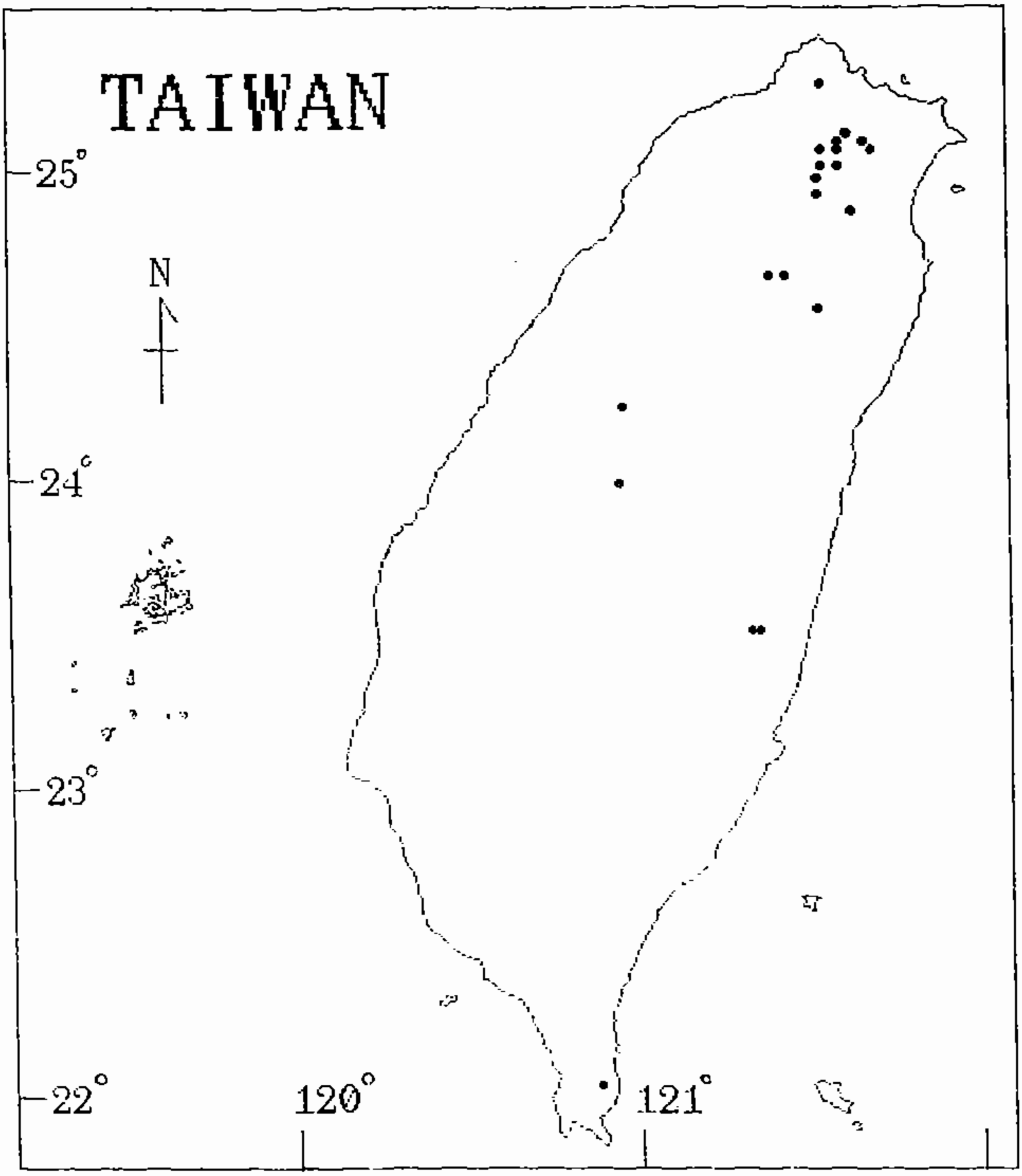
圖十五　斯文豪氏赤蛙（Rana narina swinhoana）紀錄地點圖示



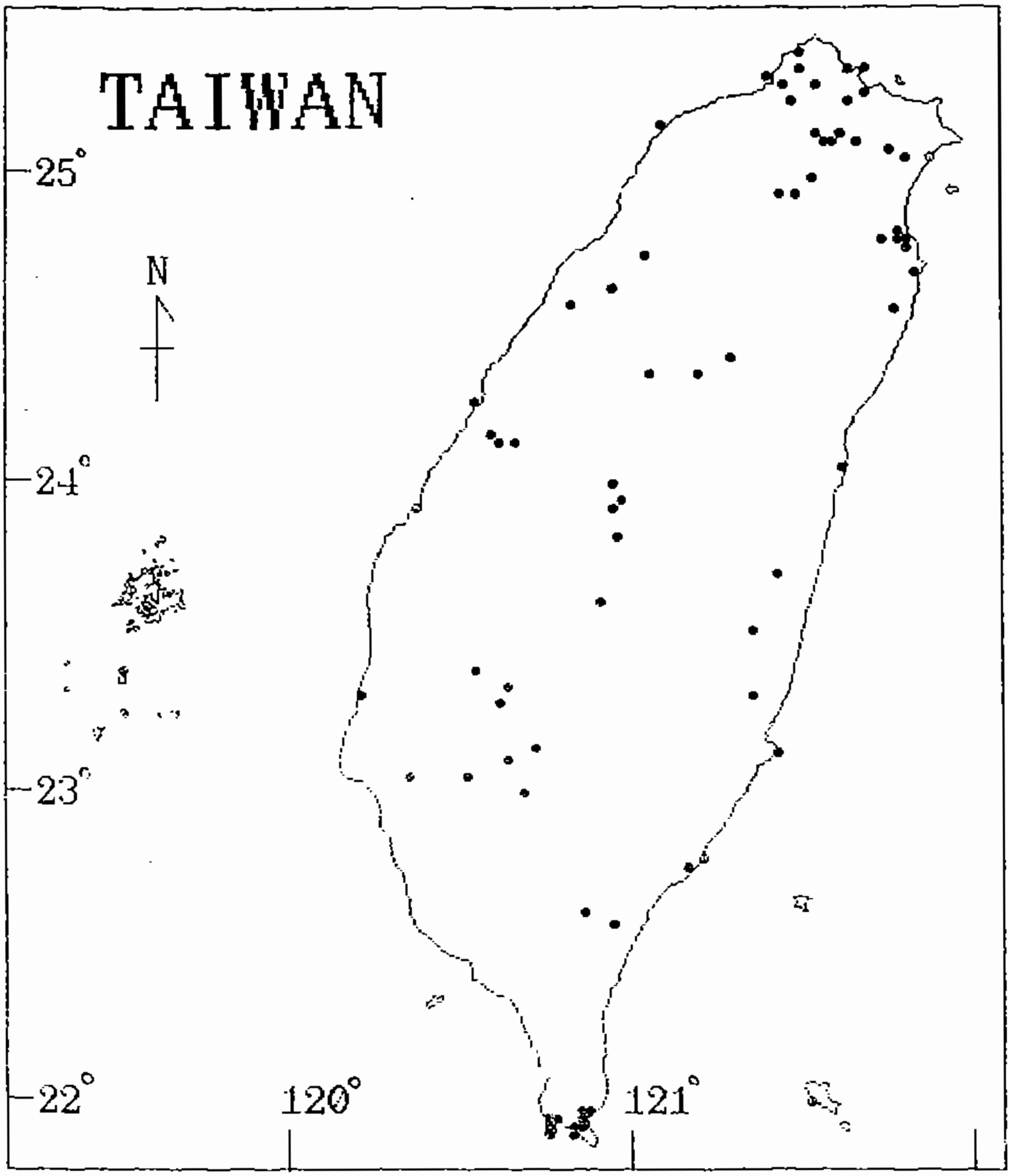
圖十六　金線蛙（Rana plancyi）紀錄地點圖示



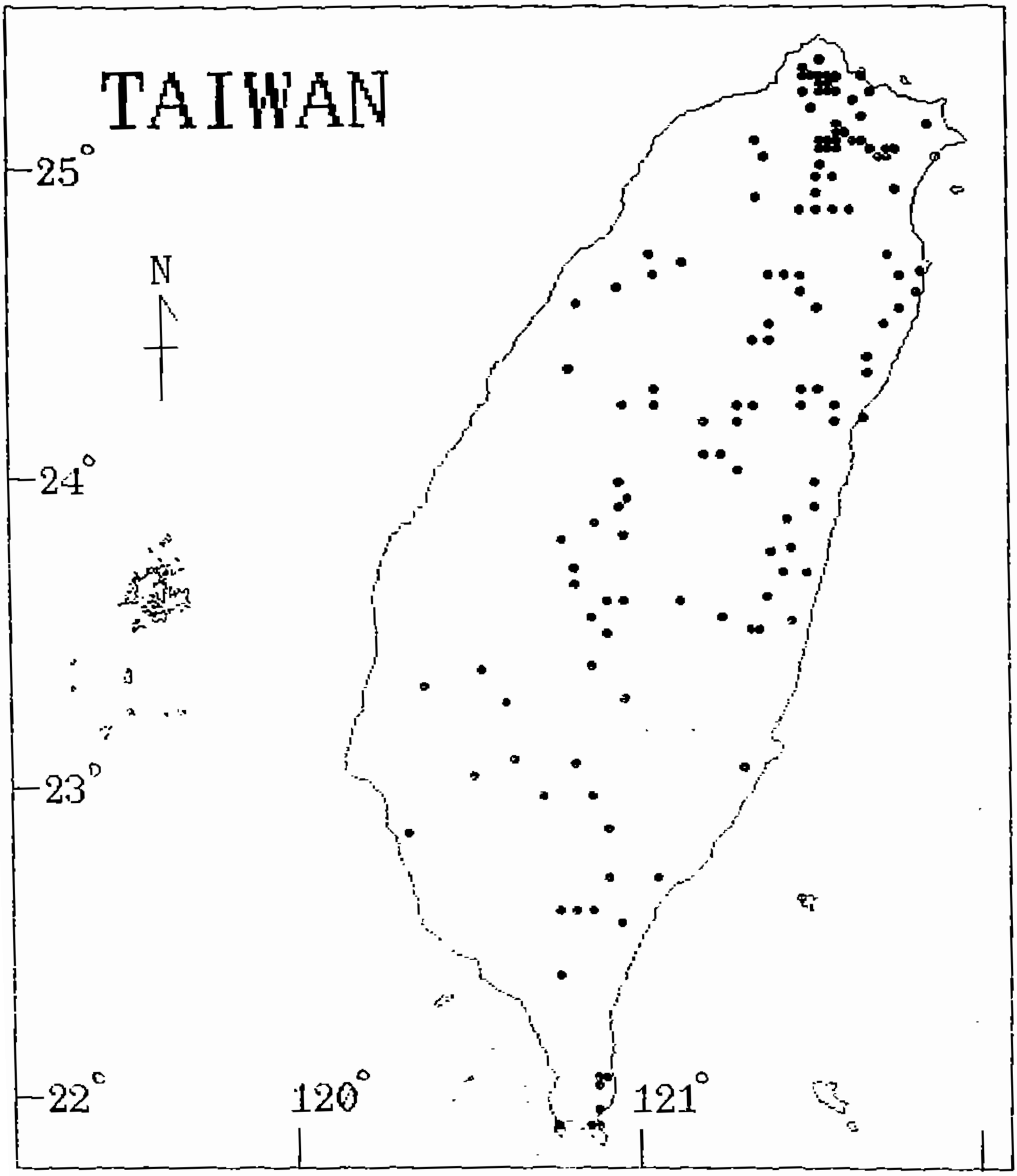
圖十七 梭德氏蛙（Rana sauteri）紀錄地點圖示



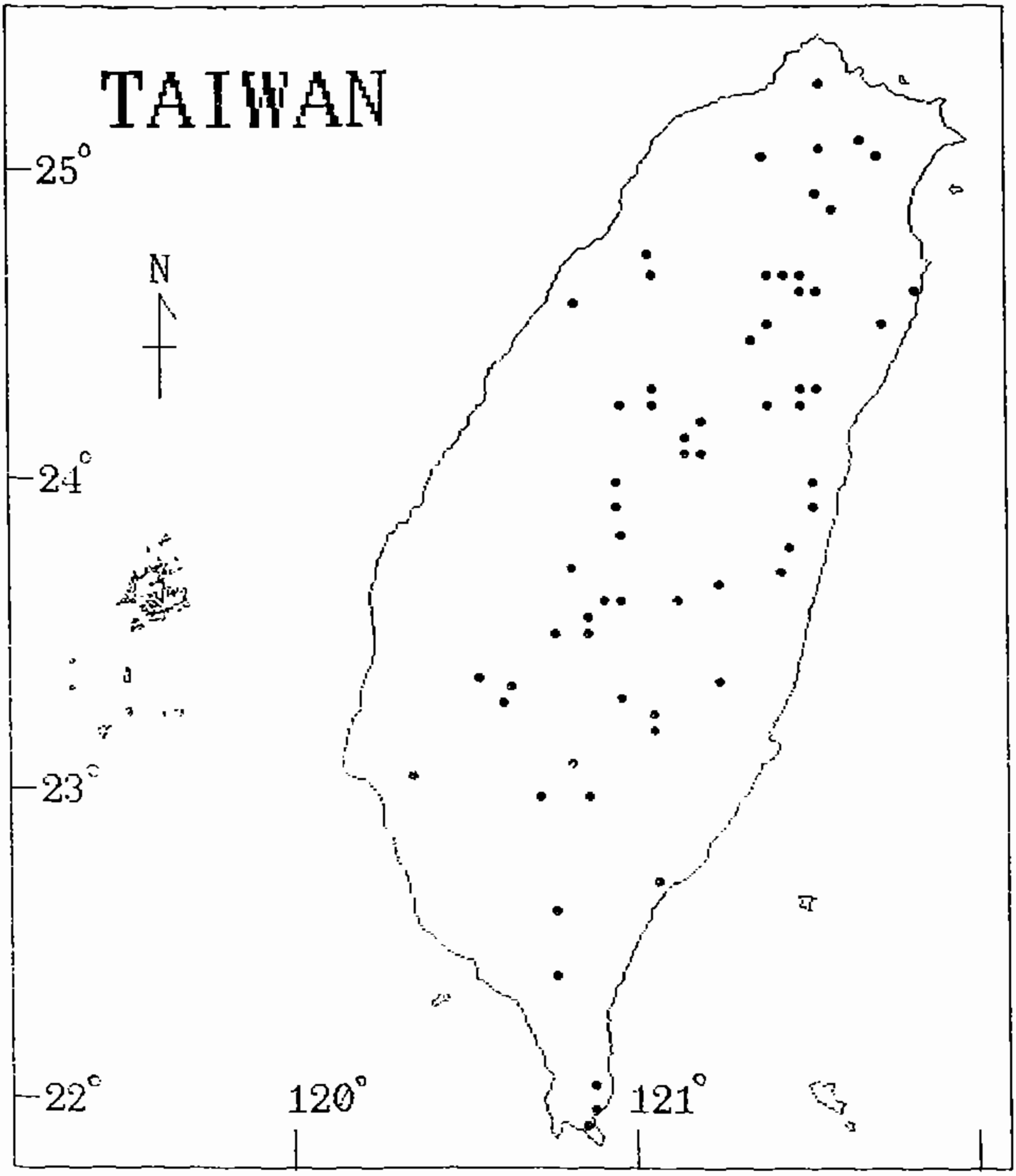
圖十八　腹斑蛙（Rana adenoplura）紀錄地點圖示



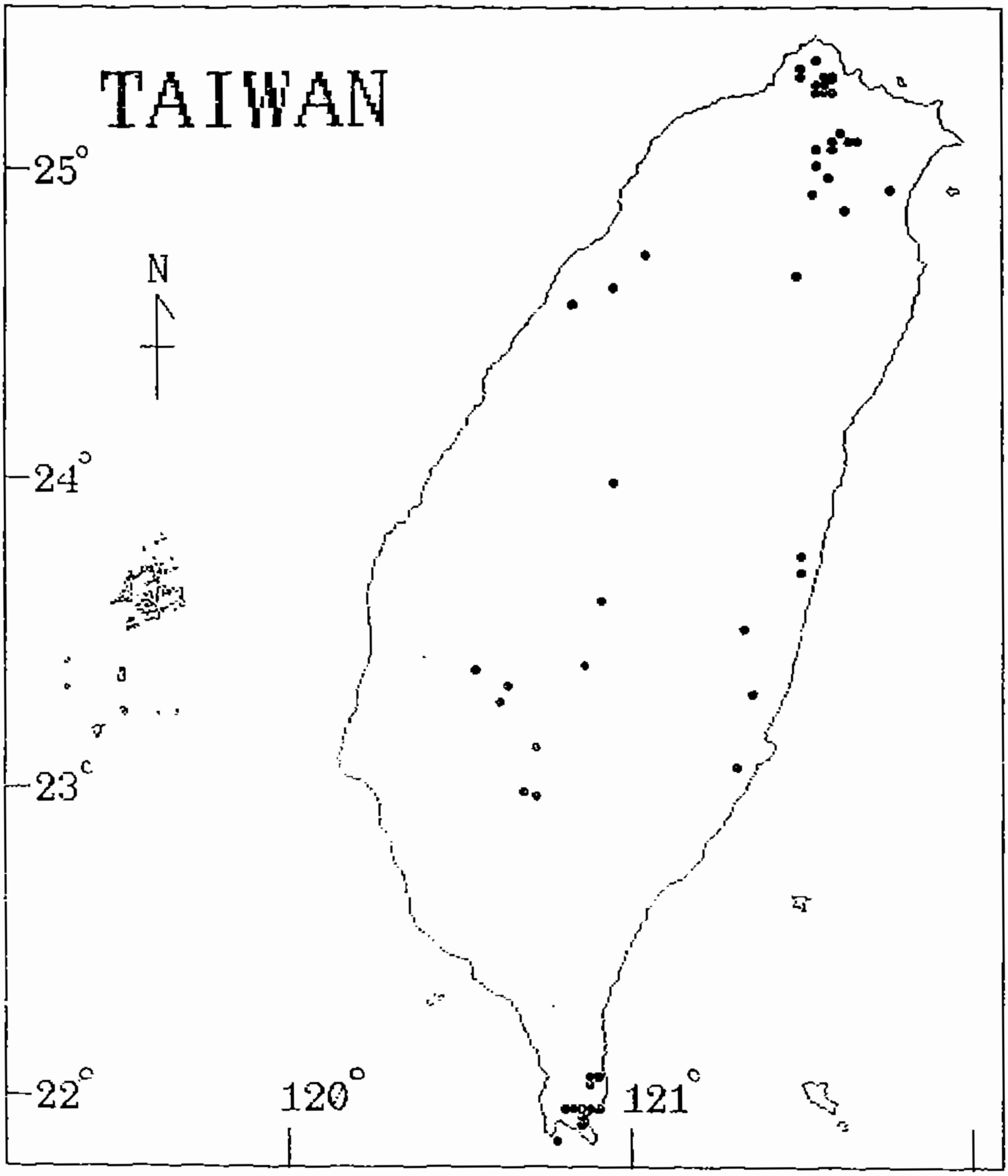
圖十九　黑眶蟾蜍（Bufo melanosticus）紀錄地點圖示



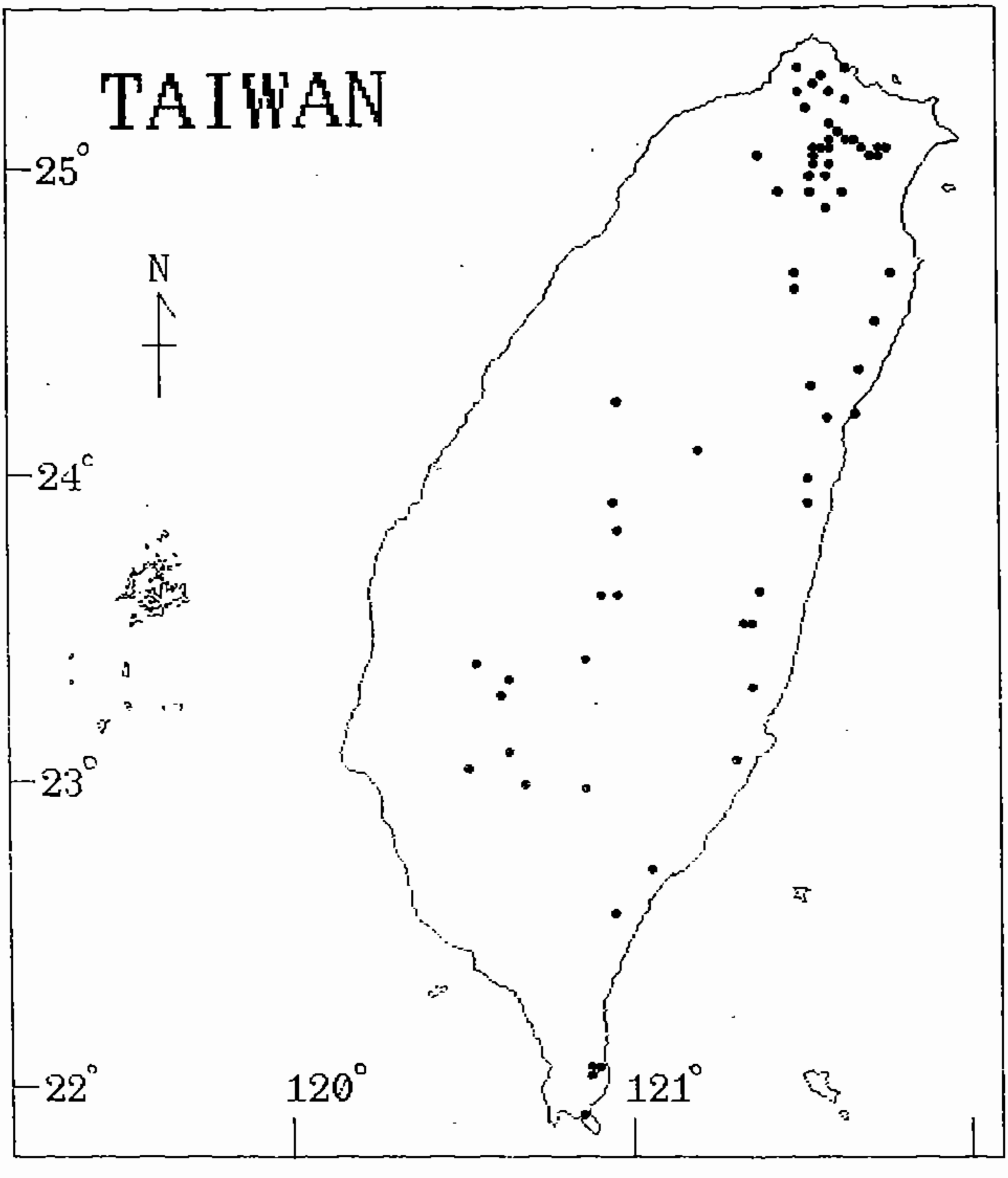
圖廿　盤古蟾蜍（Bufo gargarizans）紀錄地點圖示



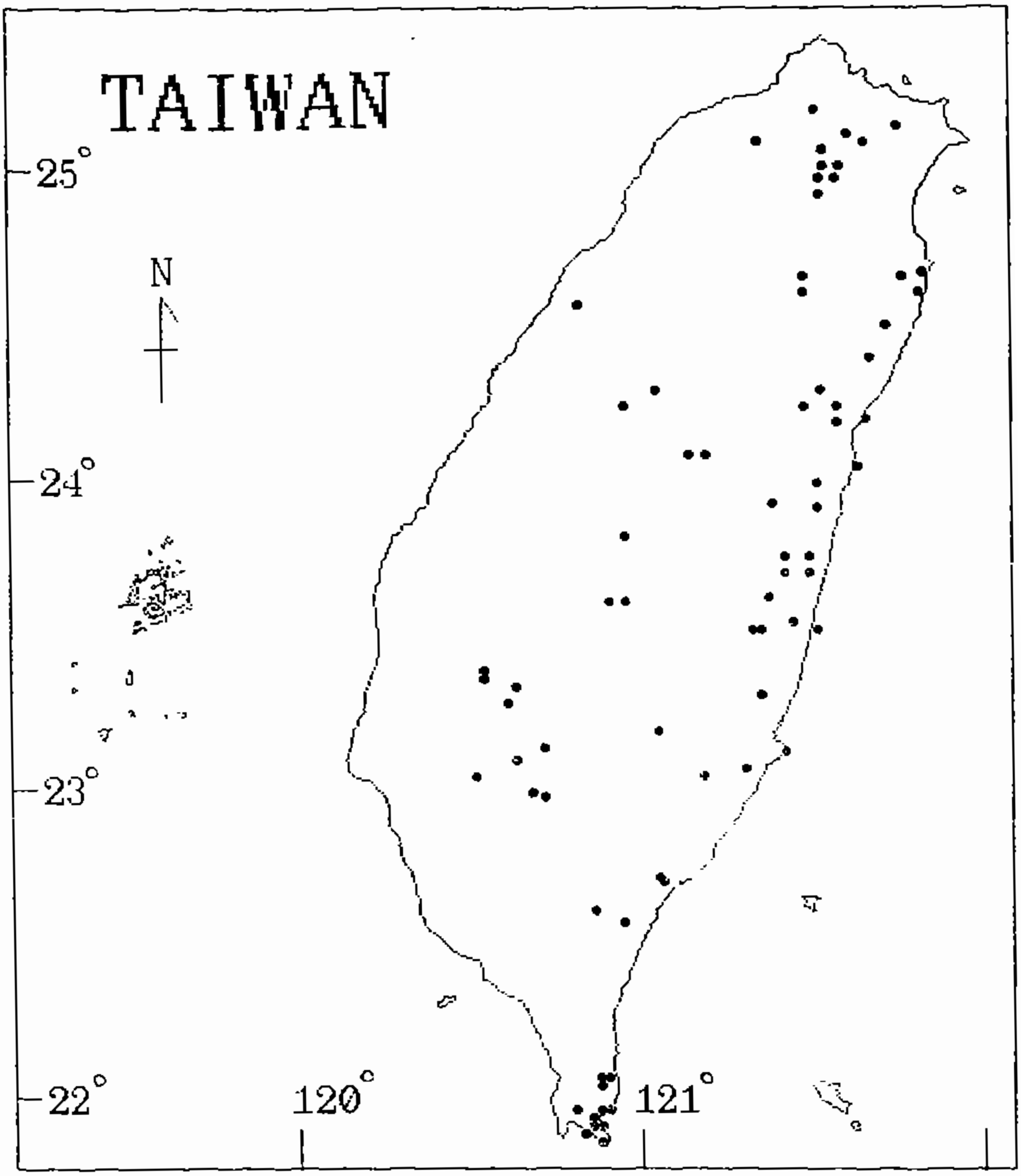
圖廿一　莫氏樹蛙（Rhacophorus moltrechti）紀錄地點圖示



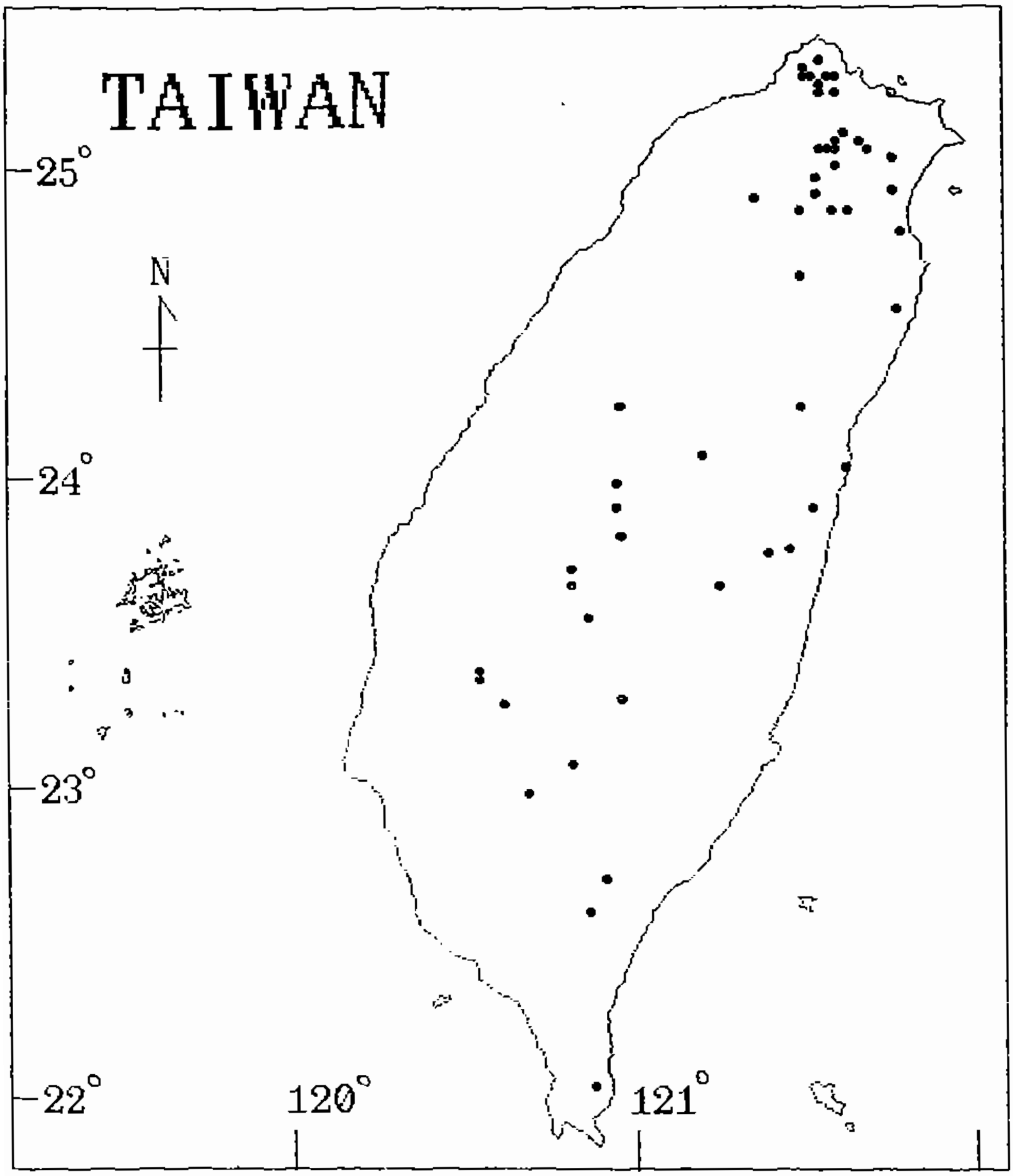
圖廿二　白領樹蛙（Polypedates megacephalus）紀錄地點圖示



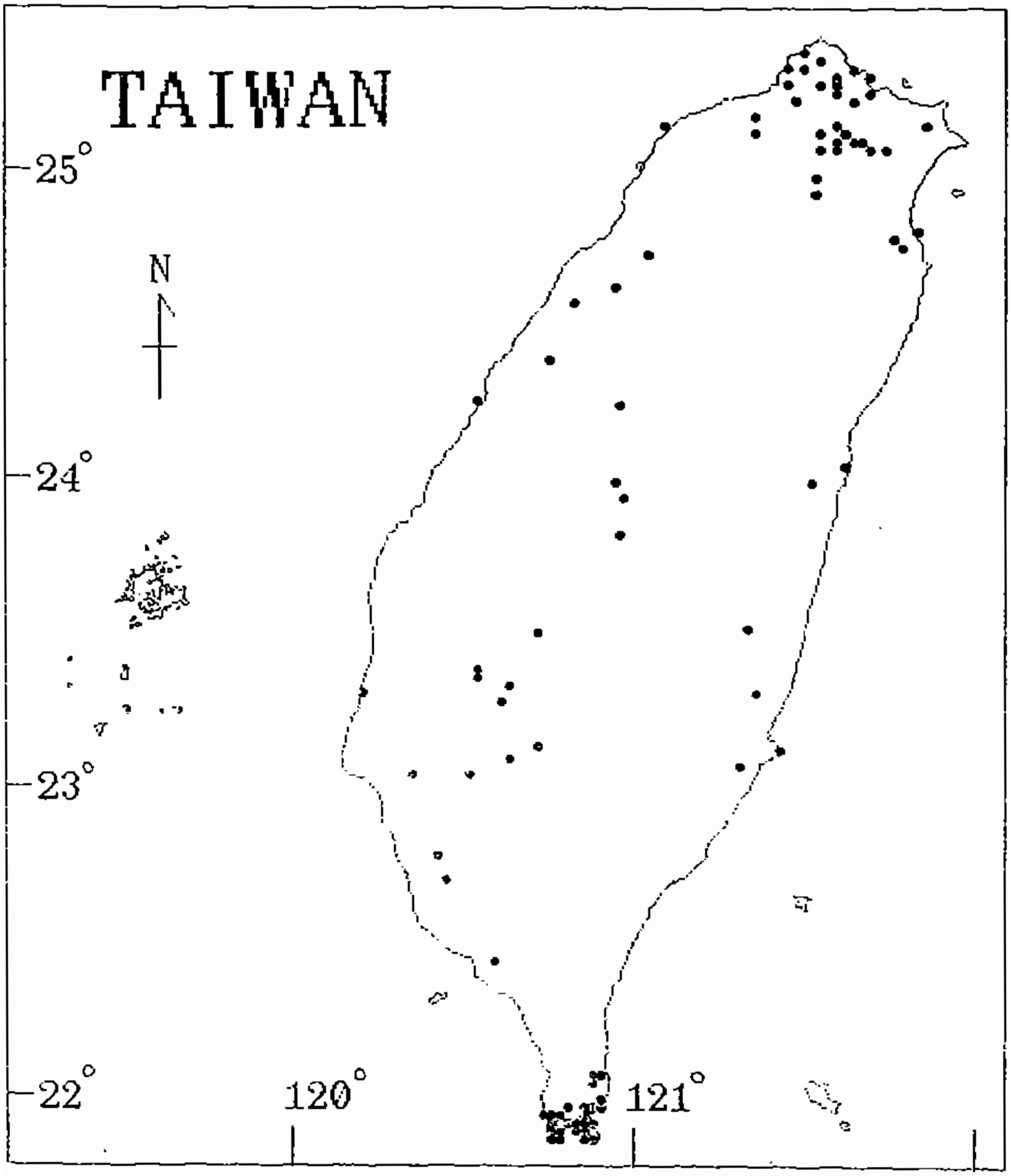
圖廿三　褐樹蛙（Buergeria robustus）紀錄地點圖示



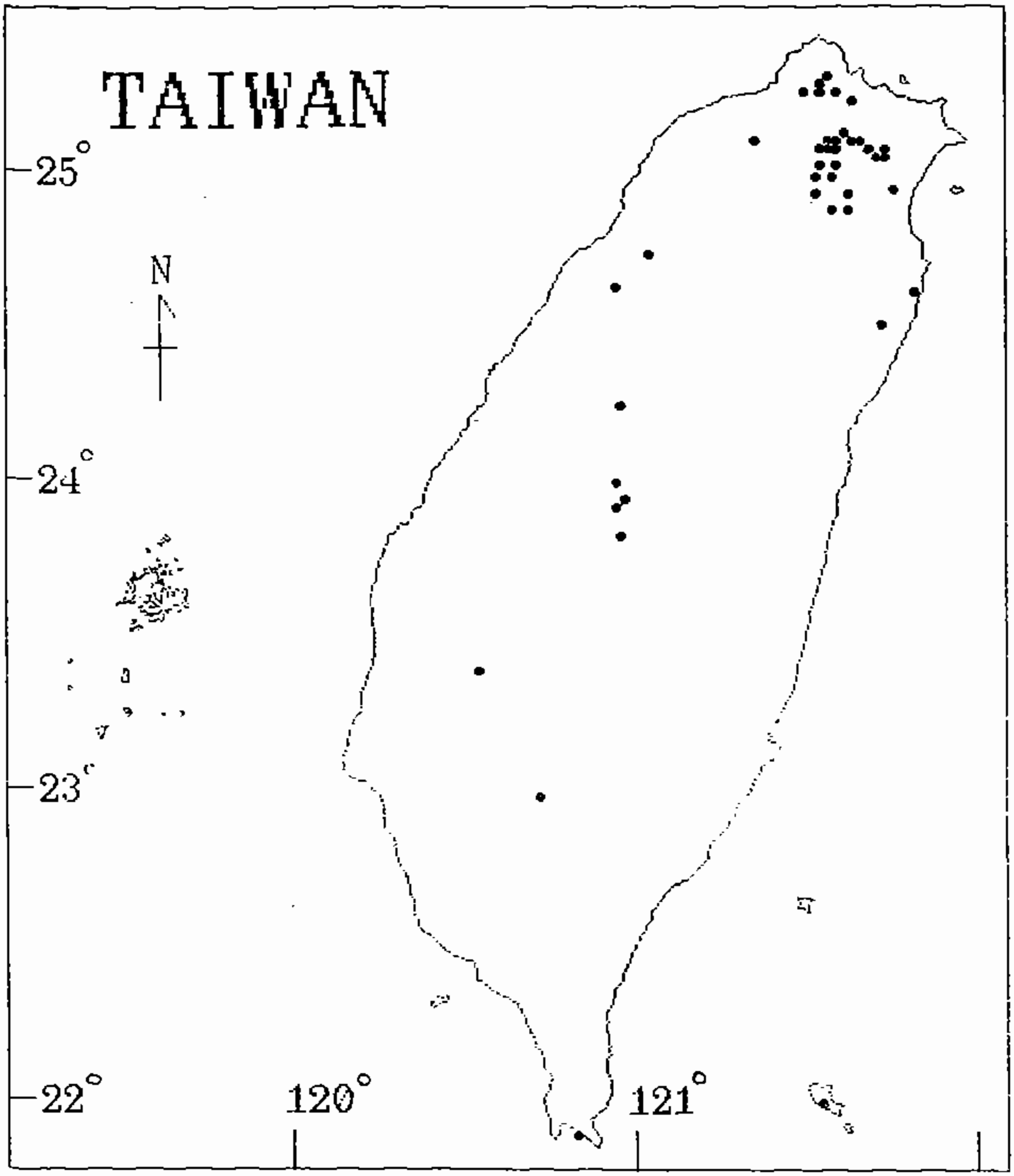
圖廿四　日本樹蛙（Buergeria japonicus）紀錄地點圖示



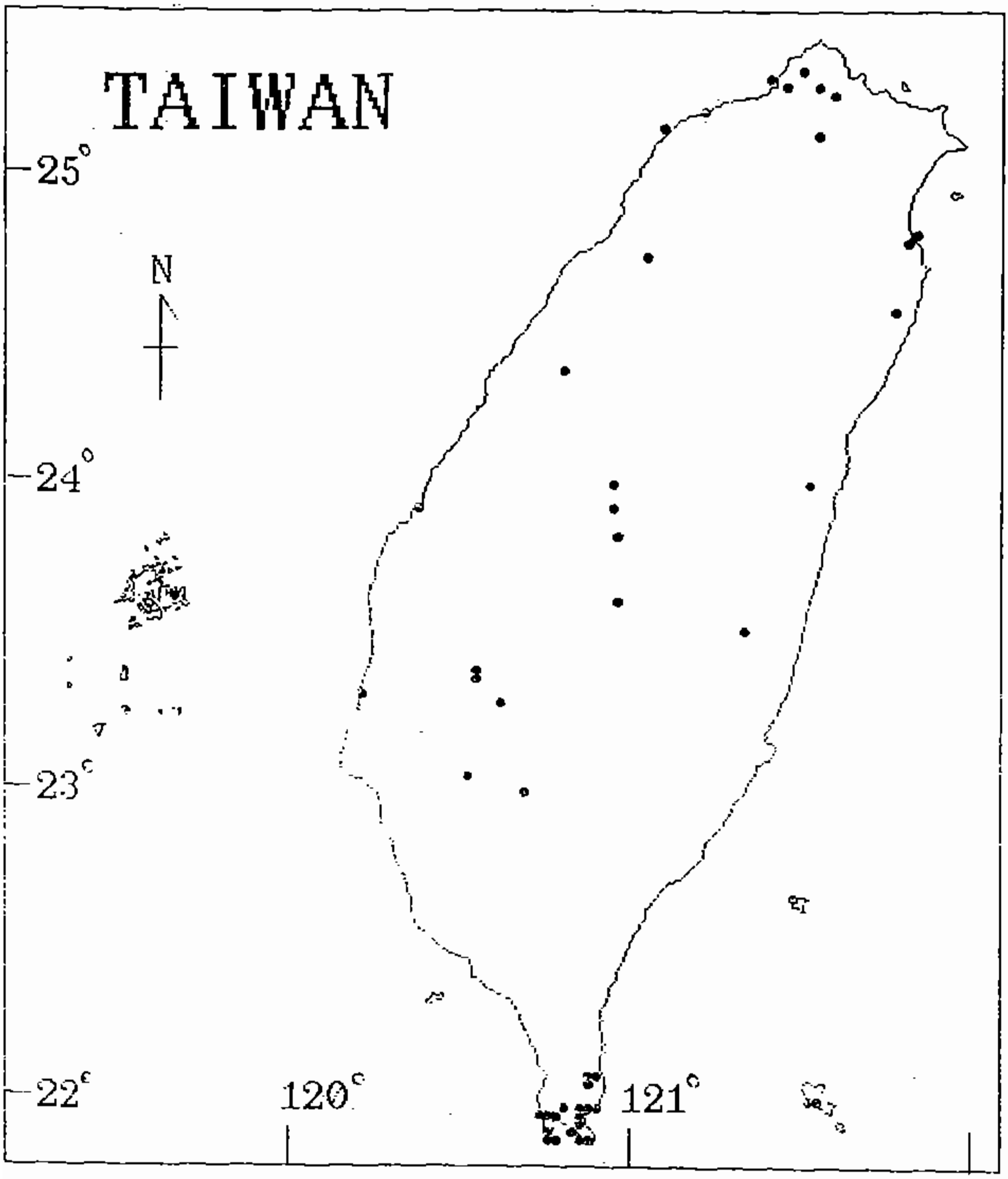
圖廿五　艾氏樹蛙（Chirixalus eiffingeri）紀錄地點圖示



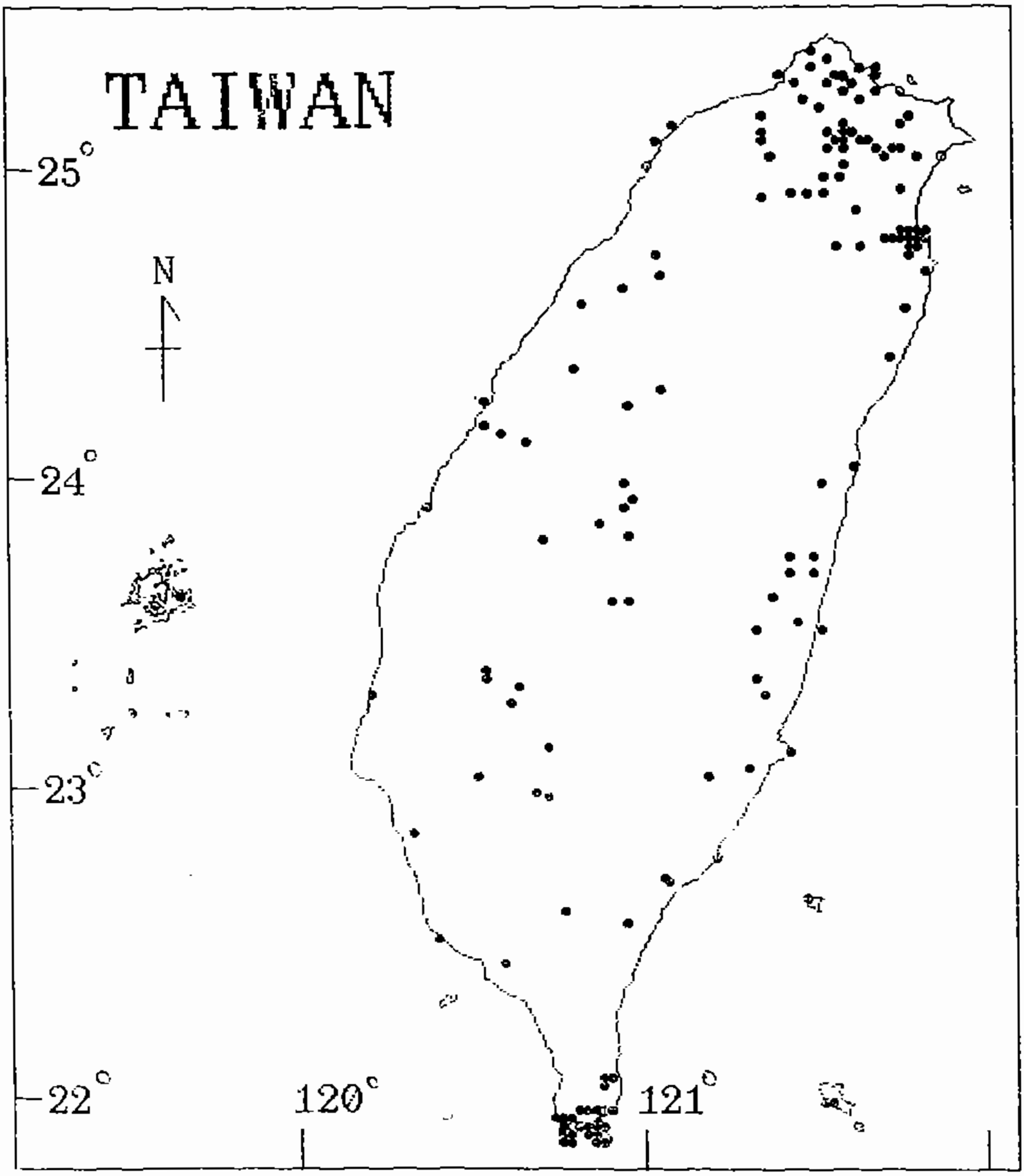
圖廿六　小雨蛙（Microhyla ornata）紀錄地點圖示



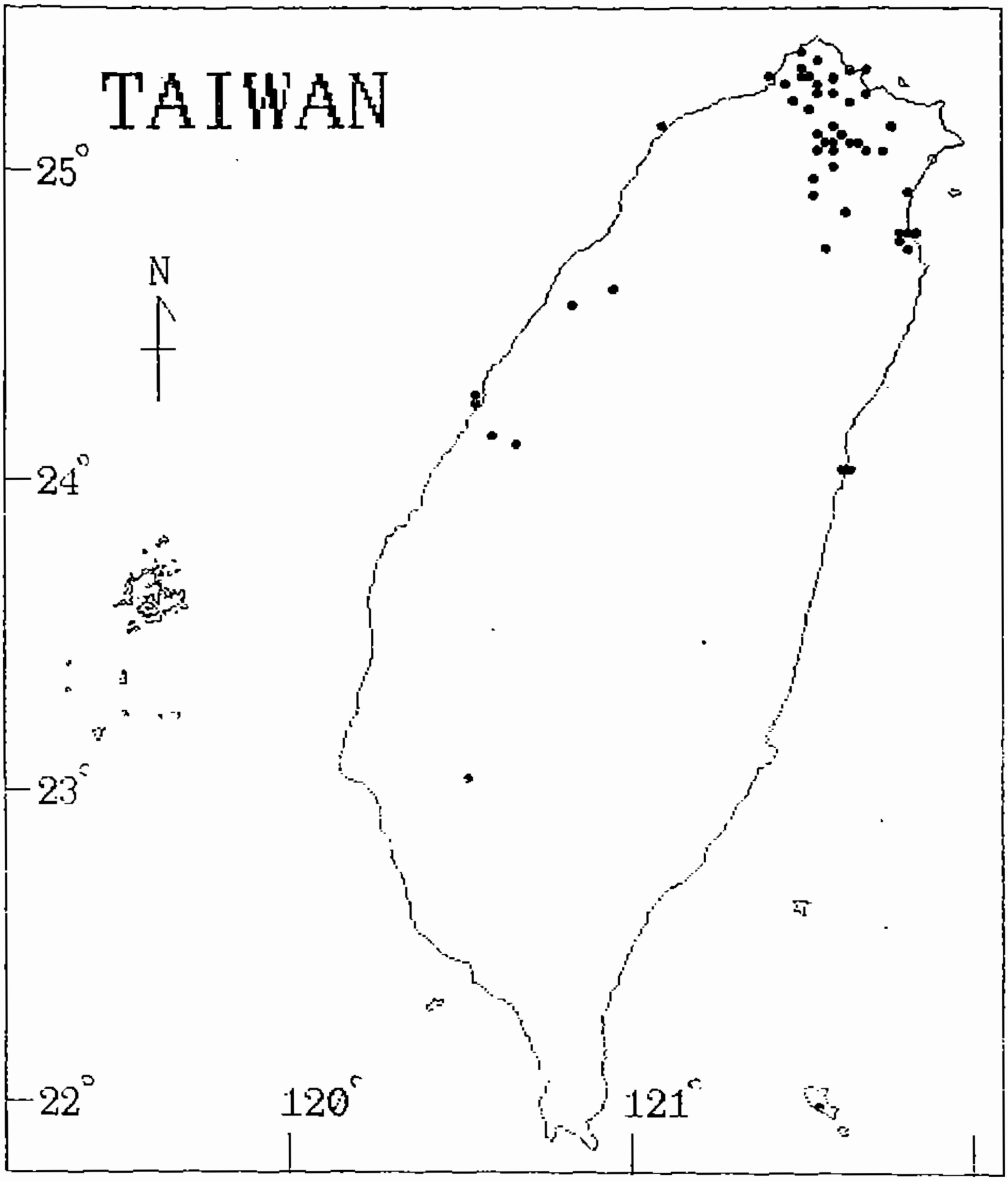
圖廿七　古氏赤蛙（Rana kuhlii）紀錄地點圖示



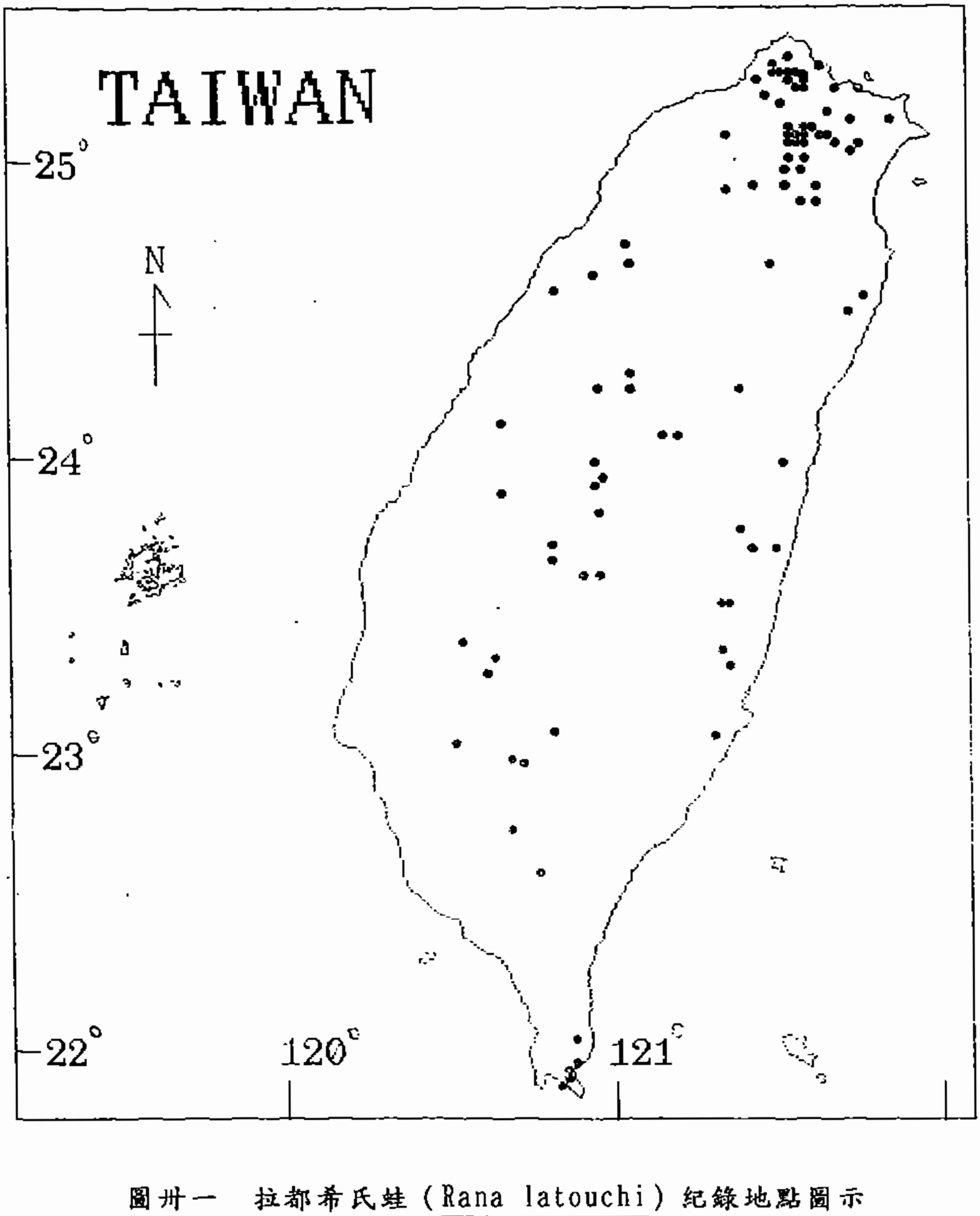
圖廿八　虎皮蛙（Rana tigrina rugulosa）紀錄地點圖示



圖廿九　澤蛙（Rana limnocharis）紀錄地點圖示



圖卅十　貢德氏蛙（Rana guntheri）紀錄地點圖示



圖卅一　拉都希氏蛙（Rana latouchi）紀錄地點圖示

122；中區 18；南區 39；東區 32 ；山脈區 92 ；北部有偏多的現象，而東區、中區和山區的調查記錄較少，但由圖之 303個調查地點來看，記錄地點還是遍布全省各地。有關兩棲類分布類型(distribution pattern) 探討的文獻相當的稀少，故要比較討論是相當困難的一件事。

至於現況類型 (Current species status) 的結果亦如表一所列：

(a).瀕臨滅絕種 (Endangered species)(E)：此種的記錄地點在303個地點中僅出現在 5個記錄點以下 (5/303 =1.65%) ，而記錄筆數在0.4%以下，且目前已知僅分布在五個區域中的一區而已，屬於這類的種類計有巴氏小雨蛙(Microhyla butleri) 和屬於南湖型的山椒魚 (Hynobius sp.) 。後者是台灣特有種。

(b).受威脅種 (Vulnerable species)(V)：此種記錄地點在5個以上，記錄筆數在 0.4%以下，而分布地點在三個區域之內者屬於這一類別的種類，計有金線蛙 (Rana plancyi) 和台北赤蛙 (Rana taipehensis) 等二種。二者都非台灣特有的種類。

(c).稀有種 (Rare species) (R)：此種記錄地點在 5個以上，記錄筆數在0.4%以上，分布在 3區域內者，計有史氏小雨蛙 (Microhyla inornata) 和阿里山型 (Hynobius sp.) 及能高型山椒魚 (Hynobius sp.)等。在此類中二種山椒魚都是台灣特有種類。

(d).無危險種 (Out of danger species) (O)：此類型的分布地點在 5-60個，而記錄地點在 4%以下，分布於2-3區者，或者分布地點在60個以上，而分布於 5區域以下者。此計有黑眶蟾蜍 (Bufo melanosticus) 、中國樹蟾 (Hyla chinensis) 、台北樹蛙 (Rhacophorus taipeianus) 、艾氏樹蛙 (Chirixalus eiffingeri)、莫氏樹蛙 (Rhacophorus moltrechti)、白頷樹蛙 (Polypedates megacephalus) 、面天樹蛙 (Chirixalus idiootocus) 、黑氏小雨蛙 (Microhyla heymonsi) 、古氏赤蛙 (Rana kuhlii)、虎皮蛙 (Rana tigerina rugulosa) 、

斯文豪氏蛙（Rana narina swinhoana）、長腳赤蛙（Rana longicrus）、梭德氏蛙（Rana sauteri）、腹斑蛙（Rana adenopleura）、貢德氏蛙（Rana guntheri）等15種。在此台北樹蛙、莫氏樹蛙和面天樹蛙是台灣特有種類。

(e).無危險且常見種（Out of danger and common species）(OC)：此類的記錄地點在60個以上，記錄筆數在 4%以上，且 5區都有分布者，記有盤古蟾蜍（Bufo bufo gargarizans）、褐樹蛙（Buergeria robustus）、日本樹蛙（Buergeria japonicus）、小雨蛙（Microhyla ornata）、澤蛙（Rana limnocharis）、和拉都希氏蛙（Rana latouchii）等六種。其中褐樹蛙是台灣特有種類。

(f).現況未知種（Insufficiently known species）(K)：如翡翠樹蛙（Rhacophorus smaragdinus），現今對於其確實的分布情形或者數量多寡皆未知。

在 IUCN 之紅皮書的定義中，有關瀕臨絕種的定義，僅指出這類生物的族群的大小已達到一臨界值以下，但並沒有指出到底臨界值究竟是多少。當然了，以生物各種不同的生殖類型和特性中，亦很難定出如此的一個臨界值。巴氏小雨蛙在亞洲大陸亦有分布，但在台灣目前僅在曾文水庫附近有記錄，其他都沒有記錄。

至於受威脅種和稀有種在 How to use the IUCN Red Data Book Categories中（1980）討論到植物時，曾以 20000 個個體的數目來訂爲稀有種的類別，但也沒有提出足夠的解釋理由，況且植物和動物也不相同。在本島的兩棲類中，金線蛙和台北赤蛙，在以往都是相當普遍的種類，但近年來已相當不易見到，足見其族群在很短的時間內已受到相當大的威脅。而稀有種類中的山椒魚，因爲是屬於孑遺種類（Relict species），只有分布在山區，且都是屬於不連續性小族群的分布。

在 IUCN 所出版有關兩棲類的 Red Data Book中，台灣的種類並沒有列在其名錄上（1982），但是顯然的有些台灣產的種類確實需要

保護。世界上其他國家出版有關的名錄並不多，筆者手上僅有美國內政部所出版的 Endangered and Threatened Wildlife and Plants, 1984, 和Edwards & Pisani, 1976, 之 Endangered and Threatened Amphibians and Reptiles in the United States 和英國 Nature Conservancy Council, 1983, 所出版的報告中有類似的名錄，但亦都沒有提及如何界定。為了保育上的需要，找到一個合乎科學上的定義是急需解決的。目前世界上在進行現況界定的機構是位於英國劍橋的 IUCN之 Conservation Monitoring Centre. 此一機構的做法是向世界各兩棲動物學家要求供給一些 Inventory Report Form (1982)，其表格的記錄內容如下:

1.國家（Country）

2.日期（Date）

3.報告者（Reporter）：姓名（Name）、地址（Address）

4.分類（Taxon）：科學名（Scientific Name）
普通名（Common Name）

5.分布（Distribution）：現在（Present）
以前（Former）

6.族群（Population）

7.棲地和有關生態資料（Habitat and Ecology）

8.對生存的威脅（Threats to survival）

9.保育措施（Conservation Measures Taken）

10.建議的保育方法（Conservation Measures Propose）

11.人工繁殖情形（Captive breeding）

12.註（Remark）

13.參考資料（Reference）

以目前台灣兩棲類的資料要來記錄這種表格尚有一段距離，但以兩棲資料庫的資料已可提供最重要的分類、分布、族群、棲地和有關的生態資料。故本報告所列的台灣兩棲類的現況已可提供一個值得參考的現況資料。

Proceedings of the First International Symposium on Wildlife
Conservation, ROC. December 1991. pp. 215-230

THE STATUS OF ENDANGERED BIRDS OF PREY IN TAIWAN

Wen-Horn Lin

Wild Bird Society of R.O.C.

Birds of Prey are among highest predators in ecosystem They are K-strategist, their low population, low breeding rate and slow growth are normal. Birds of Prey of Taiwan, the same as other wildlife, suffer from the loss of habitat, poaching, poisoning, excessive disturbance and probably competition with introduced species. These different human factors also connect with the biogical characters of each species, these characters include distribution range, habitat type, breeding behavior, food and secretiveness, etc.

21 species of birds of Prey are protected by Wildlife Conservation Law since 1989. Among these species, Crested Serpent Eagle and Mountain Scops Owl are most numerous, Hodgson's Hawk Eagle and Grass Owl are rarest in the wild by analyzing birdwatcher's records. 8 species are common sellers in birdshops, especially in spring. Among birds of Prey kept by Taipei citizens, Hodgson's Hawk-eagle is most favored, the number in cage is 53, much more than records in the wild, but some of them is believed to be imported.

Some hawks escaped from falconers not only suffer from hunger themselves, but also confuse wild bird recording.

台灣保育類猛禽現況

林 文 宏
中華民國野鳥學會

中 文 摘 要

猛禽在生態系中位居食物鏈上層，整個族群的生存策略是採精兵主義，原本數量就少、繁殖率低而成長慢。台灣屬島嶼生態系，更爲脆弱易遭破壞。台灣的猛禽也如同其他野生動物一樣受到五大方面的生存壓力，分別是棲地破壞、獵捕、污染與毒害、干擾、外來種威脅。這五種人爲影響的輕重又與每一種猛禽的生物特質有關，這些特質包括分布範圍、棲息環境、繁殖率、食性及隱秘性等。

1989年公布的「野生動物保育法」明定21種猛禽爲保育類。保育類猛禽 3年來的野外紀錄以大冠鷲與黃嘴角鴞最多，赫氏角鷹與草鴞最少。在鳥店中經常可見被販售者有大冠鷲、鳳頭蒼鷹、松雀鷹、灰面鵟鷹、領角鴞、黃嘴角鴞、鵂鶹及短耳鴞等8種，販售的高峰期是春季。台北市民的飼養的猛禽以赫氏角鷹最多，鳳頭蒼鷹次之。養鷹人所飼養的鷹常在練飛時逃逸，不僅對鳥本身構成生命危險，對野生鳥類狀況的認定也會造成混淆。

一、猛禽面臨的危機

物種滅絕的原因有二：一是演化過程中受到地理、氣候、疾病、競爭等自然因素而遭淘汰；二則是近代工業革命以後，因人爲因素的迫害而導致滅絕。

猛禽位居食物鏈的最上層，在自然界中少有天敵，因此整個族群的生存策略是採量少質精的精兵主義，即K—selection，我們可視其爲菁英物種。既是菁英物種，每一個體就會要求較大的領域、較優良的棲息環境、較營養的食物、較優遊不受干擾的空間....，簡言之，即享有較多的自然資源。這原本是牠們的生態地位所應得的，然而很不幸的是，同樣的自然資源人類也要以自己的方式加以利用，兩者產生利益衝突。當然，沒有任何物種力足以與人類競爭。菁英物種的滅絕不過是這種一面倒的爭鬥過程中你死我活的必然結果罷了。因此猛禽原本的生態地位就埋藏著易於滅絕的不利因素，包括正常族群量少、繁殖率低、成長慢等。

而人爲的干預則是變本加厲導致猛禽加速滅絕的直接原因。人爲的壓力來自五方面：

1.棲地破壞

猛禽的領域大，對棲地的要求高，對築巢地點尤其挑剔。因此對棲地破壞很敏感。

2.獵捕

猛禽形態威武，又擅獵鳥獸，自古人類就有放鷹行獵的傳統技藝，至今仍有許多人樂於擁有猛禽，包括擺設其標本。而全世界的動物園、博物館亦視其爲不可或缺的展示品，因此一直有市場上的需求。另一方面，猛禽偶爾會危害家禽家畜，這又給農民有獵殺猛禽的藉口。而猛禽本身體形大，易被發現、年復一年使用舊巢，這都增加了牠被獵捕的機會。

3.污染與毒害

由於猛禽皆爲肉食性，人類所使用的殺蟲劑、滅鼠劑、各種重金屬污染很容易經由小動物累積於猛禽身上，輕則使牠喪失繁殖能力，重則死亡。

4.干擾

猛禽的獵食天性使牠善於隱秘、埋伏，且視力極佳，警覺性高，因此對於人類活動過近過頻很難適應。

5.外來種威脅

由於市場價高，猛禽常被商人引進至原產地外的地區以供應各種買主，如鳥園、養鷹人等。而養鷹人的飼養形態以放飛回收爲樂，因此逃逸至野外的機率很高，長遠來看可能會對原生種有所影響。

二、法令的保護

與保護猛禽有關的法令始於1972年的全面禁獵令。1982年所公布的「文化資產保存法」中對於包含珍貴稀有動物在內的自然文化景觀有極嚴格的保護規定，1989年1月農委會依此公告7種珍貴稀有應予保護之鳥類，其中猛禽佔了6種（蘭嶼角鴞、灰林鴞、褐林鴞、林雕、赫氏角鷹、黃魚鴞）。1989年6月政府公布「野生動物保育法」，規定「保育類」野生動物應依法加以保育、不得迫害。保育類動物依等級又分爲(1).瀕臨絕種(2).珍貴稀有(3).其他應予保育者。同年8月農委會公告保育類野生動物名錄，1990年 8月增訂後，共有79種保育類鳥類，其中猛禽佔了21種（隼形目10種，鴞形目11種）。此即本文所檢討的對象。（表1）

三、猛禽的先天特質

1.分布特質

台灣猛禽的來源，如同整個鳥類相一樣，大多源自東方區（Oriental），少數來自古北區（Palearctic）或廣布全球者。

由表2 可看出台灣的猛禽佔有相當珍貴的地位，這可由下面幾個例子看出：(1)全世界的隼形目中僅有遊隼與魚鷹兩者是廣布世界的，而台灣亦有分布。(2)台灣有9種猛禽屬於東方區，且台灣是其島嶼分布的北限。(3)灰林鴞廣布歐亞大陸北方，台灣是分布的東南限。(4)黃魚鴞除分布於喜馬拉雅山、中國及中南半島北部外，島嶼僅台灣一地。(5) 由東北亞南遷的灰面鵟鷹與赤腹鷹經過台灣的數量為全世界最大，有可能所有族群都經過台灣（劉，1991）。(6)擁有一島嶼特有亞種蘭嶼角鴞。由以上種種可知台灣的地理位置得天獨厚，兼具不只一個動物地理區的特色。但相對地，由於位居分布範圍的邊緣，又是島嶼，很多種猛禽的數量更為稀少，生態地位更不穩定，易遭破壞。例如林雕在東方區棲於熱帶森林中，以鳥卵及幼雛為主食，因為熱帶地區鳥種豐富，鳥類的繁殖期長；而在台灣氣候不同，夏有颱風，冬有強勁蒙古高壓帶來之寒流及東北季風，林雕可能必須調適其食性與習性才得生存。又如灰林鴞是古北區溫帶森林的鳥類，孑遺於台灣者就只能生存於中高海拔的針葉林中。

2.棲息環境

棲息環境愈容易被毀滅者，物種本身自然也容易滅絕。台灣留棲的猛禽以低、中海拔種類最多（表3），由於平原及低海拔山地已遭開發，不能適應人工林者會逐漸向更高海拔消退，如赫氏角鷹與林雕；能適應人工林者則會向更低海拔擴張，如大冠鷲。原本棲息於平原及低海拔草原的草鴞可能已滅絕，而原棲於溪流旁的黃魚鴞也因處處築堤建壩毒魚電魚而範圍日減。反而是棲於中高海拔針葉林的褐林鴞與灰林鴞雖然紀錄少，但棲地可能較不會被破壞，前途仍有希望。

3.繁殖率

愈大形的鳥，繁殖愈低愈慢，但雛鳥可得到雙親較好的照顧。表4 是依體重由上往下排列，隼形目中最大形的赫氏角鷹、大冠鷲及林雕都只產1卵，鴞形目中最大形的黃魚鴞與褐林鴞僅產2卵。由於人為的干擾、獵捕等因素，這些繁殖率低的猛禽都易於滅絕。

4.食性

食性過於特化，食物易不足的鳥也容易遭到滅絕的危機。如林雕的食性很特殊，而赫氏角鷹以較大形鳥獸爲食（表4)，因此都較可能因食物來源缺乏而減少。雖然大部分猛禽以鼠、爬蟲、昆蟲等所謂的「害蟲」爲食，顯然有益人類，但也很可能間接累積殺蟲劑、毒鼠劑等毒物，尤其愈能適應人類環境者（如農田、人工林），遭毒劑爲害的可能也愈高。原本在平原地區很普遍的鳶，近年數量銳減，很可能就是這種受害者。

5.隱秘性

愈是生活於密林的鳥類，性情必然愈善隱秘；反之生活於開闊地者愈不隱秘，這大多取決於棲地與獵食的因素，少部分則與天性及後天人鳥的影響有關。性愈隱秘者，愈畏懼人類的開發與活動的干擾，但也減少被獵捕的機會；反之性不隱秘者要冒較大的被獵捕的危險，但也更能在人類已開發的地盤開創新天地。

筆者根據賞鳥人的經驗主觀地列出如下隱秘性的順序：

松雀鷹、赤腹鷹、林雕＞赫氏角鷹、蜂鷹、鳳頭蒼鷹＞大冠鷲＞灰面鷲鷹＞魚鷹、遊隼

愈左邊者愈隱秘不易見，也愈畏懼人類的干擾。在檢討鳥類之數量時，也應將此因素列入考慮。夜行性猛禽的資料過少，僅知領角鴞與褐鷹鴞可在人類聚落旁生活而毫不畏懼。（曹，1988）。

四、保育類猛禽現況

1.野外的紀錄

根據中華民國野鳥學會的「鳥類資料庫」的統計，1988至1990三年內賞鳥人士所見的保育類猛禽紀錄次數順序如下：

大冠鷲（344次)＞鳳頭蒼鷹（201次)＞松雀鷹（153次)＞魚鷹(75次)＞遊隼（33次）＞蜂鷹（29次）＞林雕（17次）＞赫氏角鷹(13次)。

此外，赤腹鷹與灰面鷲鷹秋季在墾丁極普遍。

黃嘴角鴞（40次）＞鵂鶹（27次）＞領角鴞（22次）＞褐鷹鴞(10次)＞短耳鴞（9次）＞灰林鴞（4次）＞褐林鴞（3次）＞長耳鴞（1次）＞黃魚鴞（1次）＞草鴞（0次）

此外，蘭嶼角鴞僅見於蘭嶼，估計至多200隻。（劉，1988）。

2.販售的概況

猛禽的販售就上游而言，一來自大盤商在山地定期搜購；二來自國外引進，有合法輸入也有非法走私者。就下游而言，有經由鳥店公開或半公開銷售者；有批發給小販在鬧區市集等地擺地攤販售者；也有透過養鷹人本身在同好間交易者。不論何種方式，若非公開擺設者皆很難統計其販售詳情，只有鳥店的販售可經由定期的觀察瞭解其概況。由祁偉廉、興大保育社、台大保育社於1986及1990兩度做的鳥店調查並參考部份鳥友訪查鳥店的經驗，可將猛禽依被販售情形分爲三級：

(1) 經常出現：大冠鷲、鳳頭蒼鷹、松雀鷹、灰面鵟鷹、領角鴞、黃嘴角鴞、鵂鶹、短耳鴞。

(2) 偶爾出現者：赫氏角鷹、紅隼、鳶、魚鷹、赤腹鷹、褐鷹鴞、黃魚鴞、長耳鴞。

(3) 從未出現者：林雕、蜂鷹、遊隼、灰林鴞、草鴞。

上面這個等級與野外紀錄的多寡大抵吻合，換言之，野外數量多的，被獵捕販賣的也多；野外罕見者，鳥店亦少。因此若以另一角度來看，經常在鳥店出現者其族群量應仍可觀，反而是從未在鳥店出現者可能已瀕危險，值得警惕。最大的例外是赫氏角鷹，鳥店中比野外常見，再加上私下交易者，其前途堪虞。就時令而言，春天（3-5月）是高峰期，許多幼雛在春季上市，尤其是鳳頭蒼鷹與赫氏角鷹，這段時期應列爲政府執法的重點時期。

除鳥店外，固定的市集（如台北市萬華火車站前）及不固定的小販（台北市建國花市一帶）是另一種形式的販售，以鴞形目爲主，尤其是領角鴞。在萬華區販賣者皆以食補、治氣喘等理由來推銷，而東

區之小販則以當寵物做爲賣點。

3.飼養的狀況

馴鷹源於中國古代，原爲游牧民族的傳統技藝，由於鷹隼外形威武迷人，馴鷹風氣歷數千年而不衰且流傳至全世界。台灣的養鷹風氣近年來有轉熾的趨勢，尤其台北市是全省養鷹人最多，販賣市場最大之處，其飼養狀況可做爲全省的指標。

自1989年 8月農委會公告保育類野生動物名錄至1990年12月底爲止，台北市政府接受登記的猛禽共15種、204隻(表5)。其中，瀕臨絕種的赫氏角鷹居數量之首位，高達53隻，比賞鳥人士10年來野外所見的總合還高出許多。其次分別是鳳頭蒼鷹、大冠鷲、遊隼、松雀鷹。由於赫氏角鷹與遊隼在野外極稀少，卻有如此多被飼養，其中應有不少是自外國輸入的。鴞形目方面僅有 4種，其中除極稀有的褐林鴞、黃魚鴞及外來種大角鴞之外僅有領角鴞 3隻，此情形與鳥店大量販售的情形不成比例，可能的原因有二：(1) 小形鴞不易飼養，死亡率高，因此購買者雖眾，但存活者不多。(2) 很多人買小形鴞是爲了食補，因此大部份被吃掉了。

除本地種外，亦有 4種外國種，包括美國國鳥白頭海雕及名鳥金雕。事實上筆者曾在鳥店見過的外國種猛禽並不只此，有些可能連販賣者或飼養者也不知道牠眞正的名稱。例如有些可能來自東南亞的角鷹屬（Spizaetus sp.）猛禽就常在鳥店中以赫氏角鷹的高價求售。

養鷹的風氣在台灣雖非極盛行，但也非僅是短期流行稍縱即逝的個人行爲，而是已流傳一段時日，也凝聚了部分愛好者形成次團體。養鷹人可分爲二類：一是因一時好奇而買鷹飼養，而短期內因鳥死亡或本身興趣減低而中止，另一類則是已培養出長期興趣且全心投入的資深養鷹人。前者雖只是客串性質，但卻佔了購買市場的很大比例，是鳥店及街頭兜售者的主要消費對象。後者則是養鷹人的眞正代表，大部份受過良好教育且守法，也瞭解保育稀有猛禽的重要性，但由於情感因素，難以割捨養鷹嗜好。也有極少部份養鷹人與獵人、鳥店、進口商結合爲一體，甚至藉著媒體的報導，推銷養鷹風氣擴大買賣市場，鷹之於他們，只是牟利的工具罷了。

4.逸鳥的問題

如前述，由於養鷹的形態，飼養的猛禽逸飛的比例很高。1989年9 月有一赫氏角鷹被台北市民拾獲送交中華民國野鳥學會，後經腿上皮套上的電話通知主人領回。1990年 1月一位市民養於窗台的小鳥被一鳳頭蒼鷹抓死，該鷹腳上有皮套。1990年10月士林區一市民於屋頂拾獲另一赫氏角鷹，該市民因喜愛而加以收養。此三例只是許多例子中的一小部分而已。逃逸的猛禽可能因無謀生能力而餓死，可能會利爪傷人傷禽畜，也可能一再被捕捉而迭換主人。

此外，1988年12月宜蘭出現 2隻栗鳶，1990年台北市郊有赫氏角鷹的野外紀錄，但以往北部並無紀錄。這些都有可能是逃逸鳥，諸如類似的情形都會造成判斷台灣鳥類現況的混淆。

五、結　論

台灣的猛禽以往一直受到嚴重生存壓力，有些來自棲地破壞，有些來自獵捕等其他因素（表6）。1989年保育法實施以來，政府不僅只以法律保護，也確實著手取締危害猛禽的不法行爲。這對遭受嚴重獵捕的某些猛禽而言是一個好的開始。但對於因棲地破壞、因污染、干擾等因素而減少的猛禽，恐怕不是單單執行保育法所能挽回的。在台灣的自然環境一日日趨於惡劣的情況下，這些猛禽的前途實在不甚樂觀。

養鷹人既自詡爲猛禽的愛護者，就不應再有飼養稀有種，無異殺雞取卵的短視行爲，應配合政府擔任保育本土猛禽的先鋒，協助療養、訓練政府取締沒收的猛禽，以便讓他們回歸山林。假以數年，將猛禽數量恢復至足夠的程度時，再考慮依法制定利用方式尚爲時不晚。

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表1 保育類猛禽名錄

法定保育等級	隼形目	鴞形目
瀕臨絕種	赫氏角鷹 Spizaetus nipalensis 林雕 Ictinaetus malayensis	蘭嶼角鴞 Otus elegans botelensis 黃魚鴞 Ketupa flavipes 褐林鴞 Strix leptogammica 灰林鴞 Strix aluco
珍貴稀有	大冠鷲 Spilornis cheela 鳳頭蒼鷹 Accipiter trivirgatus 松雀鷹 Accipiter virgatus 蜂鷹 Pernis apivorus 魚鷹 Pandion haliaetus 遊隼 Falco peregrinus	草鴞 Tyto capensis
其他應予保育	灰面鵟鷹 Butastur indicus 赤腹鷹 Accipiter Soloensis	短耳鴞 Asio flammeus 長耳鴞 Asio otus 黃嘴角鴞 Otus spilocephalus 褐鷹鴞 Ninox scutulata 鵂鶹 Glaucidium brodiei 領角鴞 Otus bakkamoena

表2　台灣猛禽的分布

種類	分布範圍：全球	分布範圍：古北區	分布範圍：東方區	分布範圍：東北亞	分布範圍：東亞1	狀況2	台灣地位
遊隼	v					MR	
魚鷹	v					MR	
蜂鷹		v				MR	
林雕			v			R	島嶼北限
大冠鷲			v			R	近島嶼北限
鳳頭蒼鷹			v			R	島嶼北限
松雀鷹			v			R	島嶼北限
赫氏角鷹					v	R	
灰面鵟鷹				v		M	遷移必經？
赤腹鷹				v		M	遷移必經？
短耳鴞	v					M	
長耳鴞	v					M	
灰林鴞		v				R	島嶼南限
黃魚鴞		v	v			R	唯一島嶼
褐林鴞			v			R	島嶼北限
草鴞3			v			R	島嶼北限
鵂鶹			v			R	島嶼北限
褐鷹鴞					v	MR	
黃嘴角鴞			v			R	島嶼北限
領角鴞					v	R	
蘭嶼角鴞						R	僅於蘭嶼

註：1.自東方區經華東沿伸至日本

2.R爲留鳥，M爲候鳥。MR爲北方族群會南遷，南方則爲留鳥。

3.亦含衣索匹亞區及澳洲區。

表3　台灣猛禽的棲息環境*

種　類	中高海拔針葉林	低中海拔天然闊葉林	低海拔人工	平原	濕地	註
赫氏角鷹		v				
林鵰		v				
蜂鷹		v	v			
大冠鷲		v	v			
鳳頭蒼鷹		v	v			
松雀鷹		v	v			
灰面鵟鷹			v			
魚鷹					v	
遊隼				v		及海岸
黃魚鴞		v				溪流旁
褐林鴞	v					
灰林鴞	v					
褐鷹鴞		v				
黃嘴角鴞		v				
鵂鶹	v	v				
領角鴞			v			
蘭嶼角鴞		v				離　島
草鴞			v	v		
短耳鴞					v	

*不含僅過境者

表4　台灣猛禽的體重、產卵數與食性

種　類	體重（公克）*	產卵數*	主　食
赫氏角鷹	3,150	1	哺乳類、大鳥
林雕	?	1	鳥卵、幼雛
魚鷹	1,570	2—3	魚
蜂鷹	1,290	1—3	昆蟲、蜂
大冠鷲	1,200	1	蛇、蜥
遊隼	1,010	2—5	鳥
灰面鷲鷹	400	2—3	蜥蜴、昆蟲
鳳頭蒼鷹	350	2—3	鳥、松鼠
松雀鷹	135	2—4	小鳥
赤腹鷹	120	2—5	蛙、蜥蜴、昆蟲
黃魚鴞	1,600	1—2	魚
褐林鴞	1,000	2	鼠
灰林鴞	580	3—5	鼠、鳥
長耳鴞	400	3—5	鼠
短耳鴞	390	3—8	鼠
草鴞	370	3—8	鼠
褐鷹鴞	155	3—4	昆蟲
領角鴞	120	4—9	昆蟲、鼠
蘭嶼角鴞	120	2—3	昆蟲、無脊椎動物
黃嘴角鴞	80	5—6	昆蟲
鵂鶹	60	6	昆蟲、蜥蜴、小鳥

註：*由於缺乏第一手野外資料，部份數據引用外國資料，可能有誤差。

表5　台北市民飼養且登記有案的保育類猛禽(1989.8月～1990.12月)

隼形目		鴞形目	
赫氏角鷹	53隻	褐林鴞	5隻
鳳頭蒼鷹	46隻	領角鴞	3隻
大冠鷲	37隻	黃魚鴞	2隻
遊隼	21隻	* 大角鴞	2隻
松雀鷹	11隻		
鳶	9隻		
灰面鵟鷹	5隻		
* 白頭海雕	4隻		
魚鷹	3隻		
* 金雕	2隻		
* 栗鳶	1隻		

註：*表國外種

表6 台灣猛禽的現況與危機

種類	野外普遍程度1	主要危機					前途2
		棲地破壞	獵捕	污染毒害	干擾	外來種威脅	
赫氏角鷹	*	v	v			v	×
林鵰	*	v					×
大冠鷲	***		v				○
鳳頭蒼鷹	***		v				○
松雀鷹	**	v	v		v		○
蜂鷹	**			v			○
灰面鵟鷹	***		v				○
赤腹鷹	***						○
魚鷹	**			v	v		○
遊隼	*			v		v	○
黃魚鴞	*	v	v	v			×
褐林鴞	*		v				○
灰林鴞	*						○
蘭嶼角鴞	**	v	v		v		×
草鴞	*	v		v			×
短耳鴞	**		v	v			○
長耳鴞	*						○
黃嘴角鴞	***		v				○
褐鷹鴞	**		v				○
鵂鶹	***		v				○
領角鴞	***		v	v			○

註：1.***表很普遍，**表尚普遍，*表稀有

2.○表只要加強保育法的執行，前途樂觀，×表悲觀

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THE MIGRATION, WINTERING TERRITORY AND FEEDING BEHAVIOR OF THE BROWN SHRIKE (*Lanius cristatus*)

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Abstract. The brown shrike (*Lanius cristatus*) occurs in Taiwan both as a fall and spring migrant and as a winter resident. It is a familiar bird, yet much of its bird, yet much of its biology is unknown. This study aims to study the shrike's migration, territorial and foraging behavior, and to explore how this strongly territorial species expresses that territoriality in an area where the population fluctuates widely between fall and spring.

This study took place between August 1987 and May 1990 on Tunghai University campus in Taichung, central Taiwan. A transect line was established to monitor population changes. Shrikes were trapped and colored marked for individual identification. Selected individuals were monitored to determine their territory boundaries and to record their aggressive and foraging behavior. Detailed maps were made for these territories, and invertebrates were sampled to establish the resource base for these territories.

Shrike demonstrated high fidelity to wintering territories and rused the same area year after year. Among banded birds, 12% returned to the same site for four winters, 24% returned for 3 winters, and 32% returned for two winters. None shifted to a totally different territory.

Shrike territories varied greatly in habitat type and size. No special feature appeared to be essential to a territory. The food habits, feeding behavior, and the variation in shrike foraging efficiency in different habitats and territories were analyzed.

The results showed that fall migration occurred between mid-august and mid-October with the peak time around 20 September. Spring migration took place between mid-March and mid-May. Shrikes did not pass through in concentration in the spring; thus no peak was detected. More than 75% of the wintering birds remained in the study site longer than 3 months. Territories expanded to include vacant areas when neighboring territory owners disappeared. More than 56% of the territories were reused the second year or all three years. The boundaries of other territories were greatly changed.

紅尾伯勞之遷徙、過冬領域及覓食行爲初步研究

劉 小 如

引　　言

紅尾伯勞是國內人人耳熟能詳的鳥，更是近年來政府推廣野生動物保育之過程中最先選定的保育對象之一。自民國61年以來，報章雜誌上曾有許多文章報導恆春地區居民捕捉利用伯勞的方法與程度，探討此種行爲的經濟與社會意義所反應的道德與價值觀等等。近數年更有人開始分析評估十年來針對此種鳥之保育措施之成效（梁，1988，1989；Severinghaus，1991）。但是有關伯勞的生物現象，生態需求、族群變化，及行爲等方面，研究報告卻十分稀少，僅有 Severinghaus（1968，1970）報導繫放結果，年齡與性別分析，外形特徵差異等；McClure（1974）探討由台灣過境之亞種之遷徙路線；蘇及呂（1985）研究其體內寄生蟲；邱(1986)對恆春地區紅尾伯勞生態需求之初步研究；Severinghaus（1991）分析整理台灣各地所見伯勞記錄，並對其過冬領域行爲作初步探討；及Lord Medway （1970）研究在馬來半島過冬的紅尾伯勞之遷徙現象。

本研究乃針對在台灣中部過境或過冬的鳥，調查其過境數量與季節性，研究過冬鳥之領域行爲及覓食行爲與生態。想要解答的問題包括：

1.過境鳥與過冬鳥是否同時到達研究地區？何者在前？

2.過冬鳥何時設立領域？一到達即設立？或是等過境鳥離去後才開始設立？

3.若過冬鳥是等過境鳥離去才設立領域，是早早到達過冬地點等待

時機，或是等到可以設立領域時才到達過冬地區？

4.不同外型之紅尾伯勞是否同時到達研究地區？或是各型分別先後到達？

5.不同外型之紅尾伯勞是否利用不同之棲地類型？此種劃分是否與其生殖地之棲地類型相關？

6.過冬鳥是否會多年使用同一領域？若不同鳥使用同一領域，領域之邊界是否相同？

7.各領域是否有共同之特色？面積是否相等？

8.若各領域面積不同，其大小是否與領域品質相關？

9.佔領較好領域之個體是最先到達的鳥？或是較「強壯」較有能力勝過其他競爭者的鳥？

10.若領域有好壞之別，春季個體離開過冬地區之先後是否與領域品質相關？若較好的領域空出來，剩下的個體是否會立即更換到較好的領域去？

研究地點與方法

研究地點選在台中市大度山東海大學校園內約35公頃之地區。大度山之棲息環境爲典型之台灣低海拔鄉村環境。東海大學校區中，每年八、九月均有許多紅尾伯勞過境，也有許多留下過冬，是研究其遷移及過冬行爲與生態的良好地點。校內之棲息環境可分爲林冠下層長滿灌叢的雜木林，地表植物被經常修剪的短草林，大片開闊的草生地，經整修拉直的河溝及兩岸，建築物及四周有許多人工植栽的庭園式環境等五種類型。因樹林內部與邊緣地帶之植物結構不同，故又將樹林最外圍5公尺地區定爲雜木林緣或短草林緣，其內則爲雜木林內或短草林內。

本研究始於民國76年8月1日，結束於79年5月31日，其中78年度僅進行過冬領域之範圍界定及個體辨認，未做任何測量與調查，因此主

要資料是在77年度及79年度獲得。此外77年度之研究較偏重於整體性狀況之瞭解，79年度則著重於細部資料之獲得。

一、繫放標號及外型記錄

爲能確認個體及獲得基本資料，研究人員曾於77年度及79年度設法捕捉伯勞加以測量標號。76年試用之捕捉方法包括(1)以鳥腳踏捕捉，鳥腳踏是向墾丁國家公園管理處請得一批由管理處取締沒收之違法獵具，轉做研究用。(2)以鳥網捕捉，(3)以鳥網配合食餌捕捉，及(4)以鳥網配合鳥音回播捕捉。因東海校園之棲息環境包括許多樹林及建築物，以鳥腳踏捕捉之效果遠低於在恆春半島之效果，因此最後選定並於79年度沿用的方法爲以鳥網捕捉。

凡捕得之紅尾伯勞除套上不同顏色組合之彩色腳環以供日後辨認個體外，也各套一個台北市野鳥學會繫放候鳥所使用的鋁環，同時測量每隻之喙長、喙高、吻裂、翼長、尾長、身長、跗蹠長、及體重。另外也記錄各隻伯勞之主要羽色特徵。

研究期間凡尋見紅尾伯勞，均仔細記錄各隻之羽色特徵，包括其頭部、額部、眉線、過眼線、胸、腹等位置之羽色或斑紋特徵，做爲未來辨認個體之依據或參考。

二、族群動態調查

爲判定過冬鳥與過境鳥到達之日期及數量變化，工作人員定期計數研究區中的伯勞數量。對於沒有腳環標誌的個體，則靠外型特徵來協助分辨。凡出現在相近地點之個體，若外形特徵相似，即假設爲相同之個體，若未能看清外型特徵，亦假設爲相同之個體。此種判定方法之缺點在於可能低估外型類似之個體的數量。

(A)秋季過境期

工作人員於79年度在研究區內選定一條 5.6公里長之穿越線，自78年8月15日至78年10月23日，每天於日出後 1.5小時內，以每小時 1.8公里的速度步行調查，記錄目力所及範圍內（最多不超過50公尺）

的伯勞出現地點、外形特徵、及棲地類型等。

(B)過冬伯勞族群普查

自76年8月中至77年5月中，及78年11月初至79年5月中，每二週做一次全校性伯勞普查，同時記錄伯勞活動地點、外型特徵、棲地類型等。

(C)春季過境期

除繼續觀察過冬伯勞外，自79年3月26日起，隔週進行一次與秋季過境期相同的穿越線調查。

三、過冬領域之範圍與品質

77年度9月至5月間，每月以12天時間於全校各地觀察伯勞，將其活動位置，飛行路線標記在比例尺三百分之一的地圖上，並記錄所見各種行為及行為發生地點之棲地形態與棲枝高度等。各隻伯勞之領域範圍，即是各隻鳥停棲或覓食位置，或個體間的打鬥、威嚇、展示等行為發生的地點，或迴飛的範圍之最外圍聯線。計算領域面積時，建築物或道路之面積77年度包括在內，79年度則不包括在內。

79年度過境期結束後，工作人員於校園中選定25隻伯勞為追蹤對象，其中包括12隻有腳環的鳥；選擇追蹤對象時，力求在各型棲地中追蹤之鳥數之平衡。追蹤觀察伯勞以確定領域邊界後，繪製各鳥之領域圖，並於79年二月至四月，另由此25隻鳥中選出20隻，做為覓食行為觀察的對象。隔週以一天時間至各選定之領域採集昆蟲等無脊椎動物一次，以評估被追蹤之伯勞領域內之單位面積昆蟲量。

採集昆蟲之方法為事先於各領域中依領域面積選定5至7個採樣點，採樣時以掃網法在每個樣點之地表或灌叢上揮掃五次。每次採集後，先將昆蟲在烤箱內以攝氏50度烘烤48小時後，稱取各樣點的昆蟲總乾重。

另在比例尺三百分之一的地圖上，繪製各伯勞領域之植被圖，再估算領域內各類棲地所佔的面積。

四、伯勞的覓食行爲及生態

工作人員於二至四月間由25隻伯勞中，選出20隻爲覓食行爲的觀察對象，觀察隔週進行四天，與採集昆蟲之時間相連。每天觀察時間爲早上7時至12時，下午2時至6時，每小時爲一觀察時段，每時段觀察50分鐘。每隻伯勞均輪流於各時段重覆觀察二次。觀察時，依序記錄行爲種類、發生時間、並詳細記錄棲枝高度、覓食方式、俯衝覓食之俯角及飛行距離。

結　　果

一、族群動態

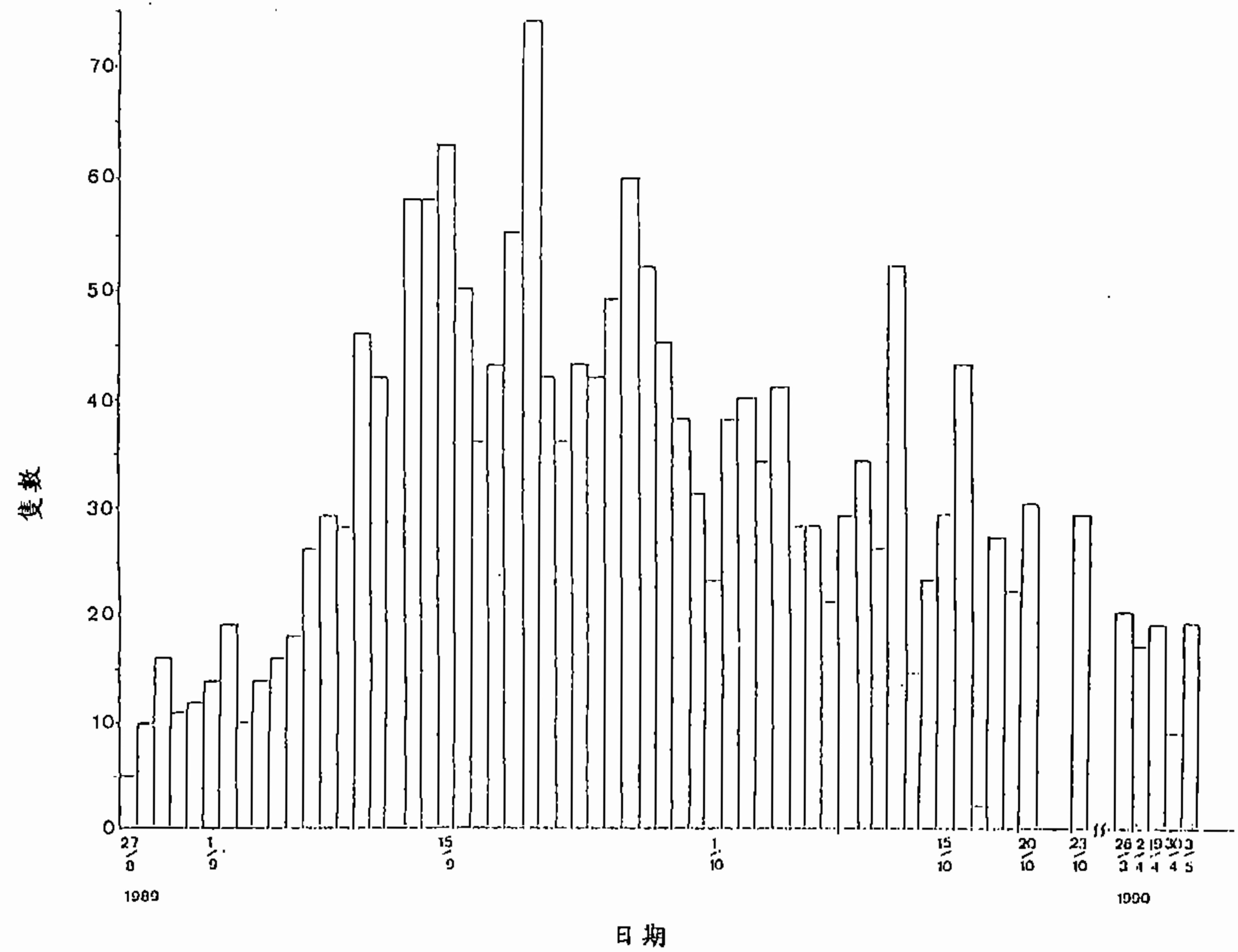
研究區中第一隻紅尾伯勞出現日期，76年是8月17日，77年是8月18日，而78年是8月26日；最後見到伯勞的日期，76年是5月16日，77年5月沒有資料，而78年是5月14日，年與年間的變異很低。

A.秋季過境期

依78年穿越線上所得結果，自8月27日起伯勞數量逐日增加，9月中旬至10月中旬是數量的高峰，然後逐漸減少，到10月下旬漸趨穩定（圖一）。因此判定秋季過境期爲八月中至十月中，滯留到10月15日以後的個體是過冬鳥。78年秋季穿越線上共有 647隻伯勞過境，另有16隻過冬鳥在穿越線上活動。過冬鳥到達之日期較過境鳥稍晚，遲至9月11日才開始出現。

過境伯勞中，50.2%的個體僅在研究區內停留一天，滯留天數超過10天以上者僅佔總數之8.5%（表一）。

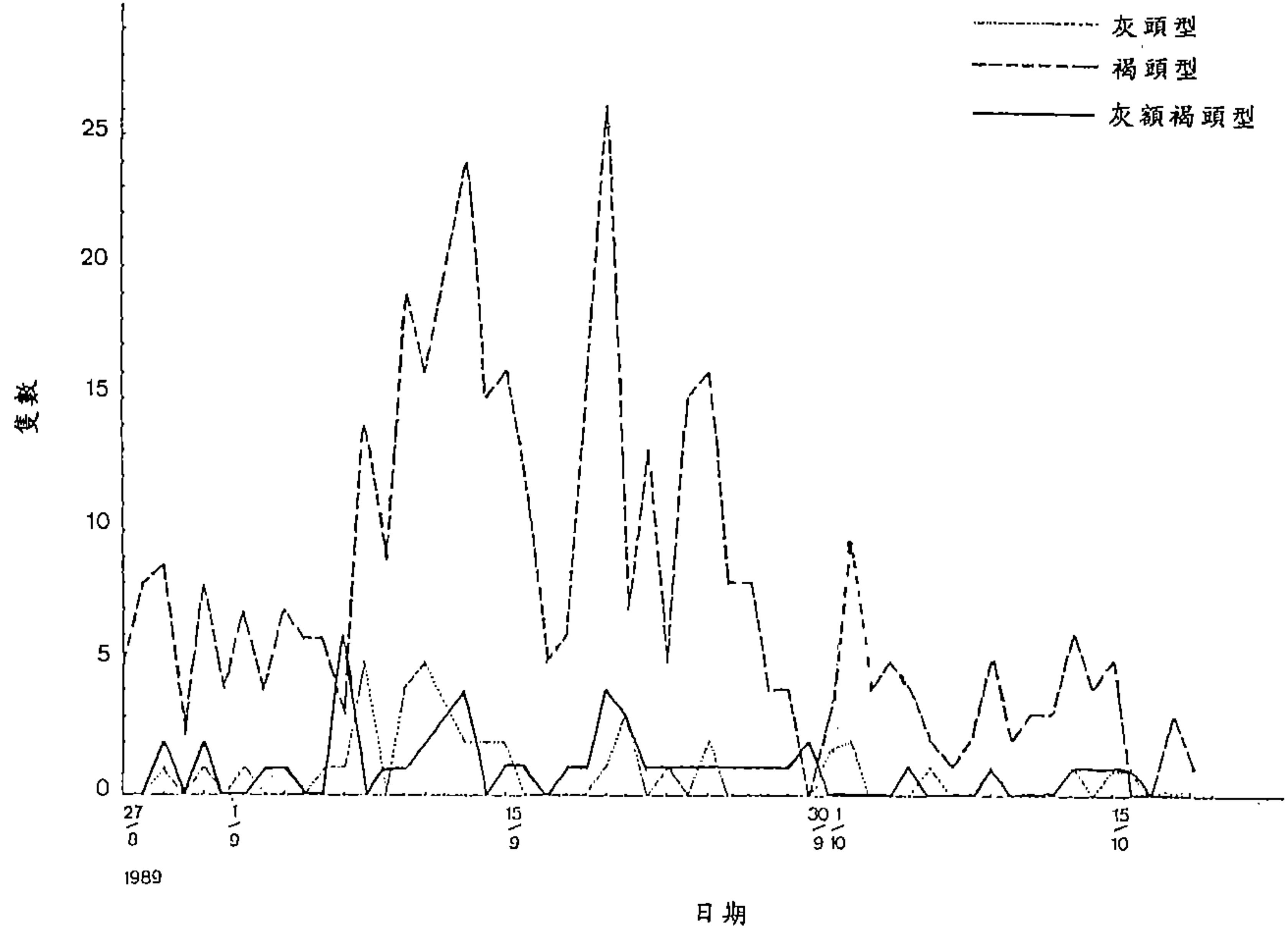
過境紅尾伯勞之羽色在個體間差異很大。依鄭作新提供之紅尾伯勞亞種分辨標準（1989個人通訊），經過台灣的鳥可大致分爲褐頭、灰頭、及灰額褐頭三型。除了178隻之資料不足無法定型之外，過境鳥中以褐頭型佔大多數（386隻），灰頭及灰額褐頭型各僅有41隻和48隻。三型抵達研究區的時期及數量高峰大抵相同（圖二）。過境期間各型



圖一　每日穿越線上所見紅尾伯勞隻數

表一　秋季過境紅尾伯勞於研究地區停留天數表

天　　數	隻　　數	百 分 比
1	325	50.2
2	42	6.5
3	48	7.4
4	36	5.6
5	37	5.7
6	32	4.9
7	28	4.3
8	18	2.8
9	13	2.0
10	13	2.0
11	12	1.9
12	4	0.6
13	5	0.8
14	5	0.8
15	2	0.3
16	4	0.6
17	2	0.3
18	3	0.5
19	4	0.6
22	1	0.2
23	1	0.2
24	1	0.2
25	3	0.5
26	1	0.2
27	1	0.2
31	2	0.3
35	2	0.3
38	2	0.3



圖二　每日抵達穿越線之不同型紅尾伯勞隻數

伯勞出現地點之棲地類型並無依鳥之外型而劃分的現象（表二，X^2 ＝8.057，df＝8，n.s.）。各型伯勞在穿越線上之分布與數量也無各型分別聚集之現象（表三，X^2 ＝27.827，df＝24，n.s.），不過穿越線上各區段所見之伯勞累積密度不同，基本上短草林、河溝或草地中的伯勞密度較高，但也會受不同干擾程度（行人路過）的影響。

B.過冬期

根據79年度普查的結果，79年3月15日以後過冬伯勞開始大量消失（表四），故以3月15日之後爲春季過境期。過冬期間每個月都有新個體在研究地區出現，也有部份個體消失，所以每月之伯勞領域數並不相同，以三月上旬之數量最高（104隻）。因爲研究地區棲地複雜造成觀察上的困難，並非每次都能觀察到每一隻過冬伯勞，所以每月所見隻數均低於渡冬鳥之總數（116隻）。

渡冬鳥在研究地區停留的時間，最短不到一個月，最長超過七個月，合計有91隻（78.45%）停留超過3個月，而以停留4.5個月的隻數最多（圖三）。

渡冬鳥中愈早到達研究地區者，在研究地區停留的時間也愈久（r＝0.966，n＝20，p＝0.001)。

在資料完整的111隻渡冬鳥中，褐頭型佔76.6%（85隻）、灰額褐頭型及灰頭型各佔16.2%（18隻）及7.2%（8隻）。若不考慮隻數過少的灰頭伯勞，另兩型渡冬利用之棲地形態，並無統計上的差異（表五，X^2 ＝3.966，df＝4，n.s.）。

C.春季過境期

工作人員在79年度春季過境期共做了六次穿越線調查，前五次之調查除4月30日隻數較少外，均有約20隻紅尾伯勞在穿越線附近活動，但至5月14日時，則已全部離去（圖一）。

依據79年度全區普查的資料，伯勞數量自3月下旬開始減少，4月時減少速率增加，至五月則已全部離去。春季過境期間並不如秋季有大量伯勞同時過境，79年春整個校區中僅見10隻過境鳥。此種過冬伯

表二　各型伯勞出現地點之主要棲地類型相關性比較

(　)中爲期望值

	雜木林	短草林	河　溝	草　地	庭　園	總　計
灰額褐頭	2 (3.63)	14 (8.48)	9 (9.98)	4 (6.43)	11 (11.47)	40
灰頭	3 (3.36)	6 (7.85)	10 (9.23)	9 (5.95)	9 (10.61)	37
褐頭	34 (32)	71 (74.6)	88 (87.80)	56 (56.62)	103 (100.92)	351
總計	39	9	107	69	123	428

$X^2=8.057$
df ＝8
P ＝0.428

表三　各型伯勞秋季在穿越線各區段之分布比較

區段	長度（公尺）	棲　地　類　型	各型隻數				密　度
			褐頭	灰頭	灰頦褐頭	總隻數	（隻／100公尺）
1	213	雜木林，短草林	25	2	3	30	14.08
2	55	短草林	9	1	0	10*	18.18
3	475	河溝，庭園	38	4	7	49	10.32
4	613	河溝，庭園	40	2	4	46	7.50
5	295	雜木林，河溝	32	7	3	42	14.24
6	579	庭園	45	4	4	53	9.15
7	222	河溝	11	0	0	11*	4.95
8	144	草地	16	4	1	21	14.58
9	500	草地，庭園	35	6	5	46	9.20
10	228	庭園	11	0	3	14	6.14
11	154	庭園	2	0	1	3*	1.95
12	492	庭園	39	2	1	42	8.54
13	188	短草林，河溝	29	4	3	36	19.15
14	115	河溝，庭園	5	0	0	5*	4.34
15	173	庭園	3	0	1	4*	2.31
16	232	短草林，庭園	19	2	6	27	11.64
17	95	河溝，庭園	8	2	3	13	13.68
18	379	庭園	4	0	1	5*	1.32
19	123	庭園	0	1	0	1*	0.81
20	120	庭園	0	0	0	0*	0.00
21	187	雜木林	15	0	2	17	9.09
總數	5582		386	41	48	475	8.51

* 計算各型伯勞於各區段之分布之X^2 時，因該區段之期望值小於1，故未列入計算。
Chi-square＝26.958，df＝24，P＝0.306

表四　78年11月至79年5月研究區中紅尾伯勞族群動態

	月				份				
	11	12	1	2	3(上)	3(下)	4	5	總計
該月總族群數	38	45	90	98	104	96	91	36	-
該月新發現數	38	9	45	12	12	1	7	1	125
11月消失數	2	-	-	-	-	-	-	-	2
12月消失數	0	0	-	-	-	-	-	-	0
1月消失數	4	0	0	-	-	-	-	-	4
2月消失數	1	0	3	2	-	-	-	-	6
3月上消失數	0	0	0	4	5	-	-	-	9
3月下消失數	3	3	6	0	0	-	-	-	12
4月消失數	14	2	22	5	5	1	7	-	56
5月消失數	14	4	14	1	2	0	0	1	36

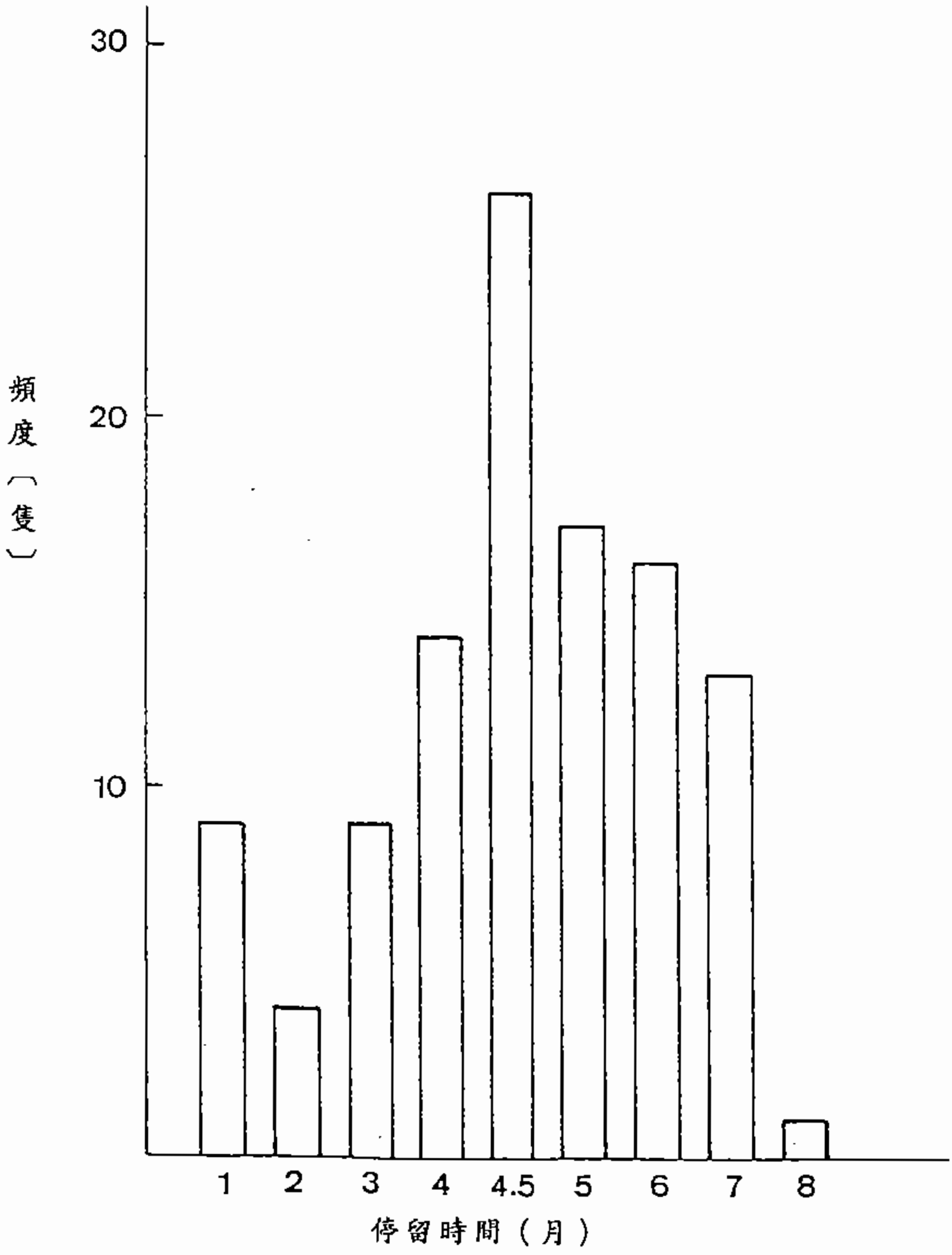
表五　不同型過冬伯勞對棲地利用之比較

	領域內主要棲地類型					
伯勞類型	樹　林*	河　溝	草　地	庭　園	棲地複雜	總　數
灰頷褐頭	4 (3.15)	4 (2.45)	1 (2.27)	7 (9.09)	2 (1.05)	18
褐頭	14 (14.85)	10 (11.55)	12 (10.73)	45 (42.91)	4 (4.95)	85
總計	18	14	13	52	6	103

*：得自雜木林之資料太少，故將短草林及雜木林合併爲同一項

(　　)中爲期望值

Chi-square＝3.966，df＝4，P＝0.411



圖三　渡冬伯勞在研究地區停留時間長度分布
（停留4至5個月者因隻數眾多，因此分成二時段來看）

勞於春天零星離去，僅有少數新鳥過境的現象，與77年春的觀察相同。

二、過境鳥與過冬鳥之比較

兩年度中各型過冬鳥之隻數比例，與秋過境鳥之各型比例並無明顯差異（$X^2=3.688$，df＝2，p＝0.158），過冬與過境鳥在外型尺寸上也十分相近，喙高、翼長、尾長、身長、跗蹠長均相同，過境鳥之喙長較長，過冬鳥之吻裂較長，但此二項測量值均屬於易因測量者不同而產生變異的項目。兩組鳥間唯一重要的差異在兩者之體重，過境鳥明顯地較過冬鳥重，顯然經過研究地區時過境鳥體內存貯了較多的脂肪（表六）。

三、伯勞之食性及覓食行爲

伯勞的食物以昆蟲等無脊椎動物及爬蟲類爲主（表七），雖然77年度共見伯勞覓食878次，其中831次食物很小(<1cm)，79年度共見1322次，其中1291次之食物小於1公分，僅少數大於5公分，因此大半無法鑑定種類（表七）。

79年度所見伯勞覓食方式有對地面俯衝然後啄食地面食物（1178次）飛啄植物上的食物（106次），飛擊空中的昆蟲（31次），及站在植物上啄食（7次）等。獲得較大的食物時，伯勞常會將食物卡在植物的枝條間、刺上、或其他適當位置（如鐵刺網）上加以固定，再撕食；吃不完的食物會被留在固定的位置，等需要時再回來取食。

伯勞覓食前的棲枝高度大部份集中在0.5至2.5公尺之間（59.4%，n＝1293，圖四）。在不同棲地中，伯勞覓食之平均棲枝高度有別，由高至低依序是河溝、短草林內、短草林緣、庭園、雜木林緣及雜木林內。草地上之棲枝有限，因此伯勞常棲坐電線上，使得在草地上的棲枝高度有雙峰形的分布。

伯勞俯衝到地面捕食時與垂直線形成之俯角以0至10度及40至60度最多（圖五），伯勞在不同棲地中最常使用之俯角不同，其眾數由大至小依序是河溝、草地、庭園、短草林內及短草林緣（雜木林內及邊

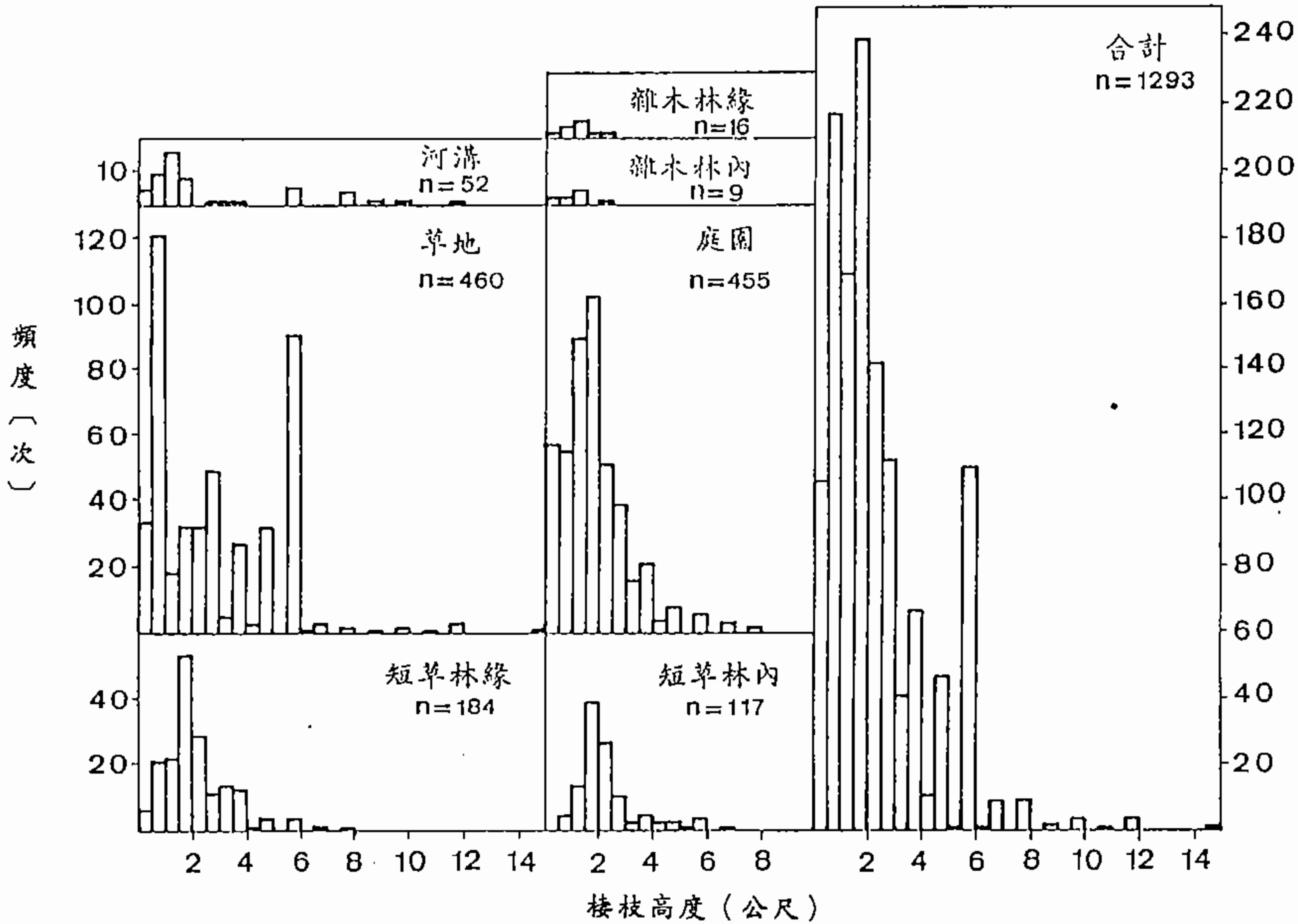
表六　秋過境鳥與過冬鳥各項外形長度及體重之比較

項　目	過　境　鳥	過　冬　鳥	P值（t test）
喙長	16.74±1.07 (30)	16.14±0.96 (38)	0.0193
喙高	8.27±0.53 (29)	8.47±0.29 (38)	0.0879
吻裂	22.11±1.24 (30)	22.68±0.91 (37)	0.0401
翼長	87.42±2.53 (30)	86.44±4.73 (38)	0.2753
尾長	88.37±4.14 (30)	90.33±4.53 (37)	0.0690
跗蹠長	25.40±1.07 (30)	25.57±1.06 (38)	0.5137
身長	194.26±6.46 (29)	194.27±11.08 (36)	0.9951
體重	33.24±2.33 (24)	30.07±1.65 (14)	0.0001

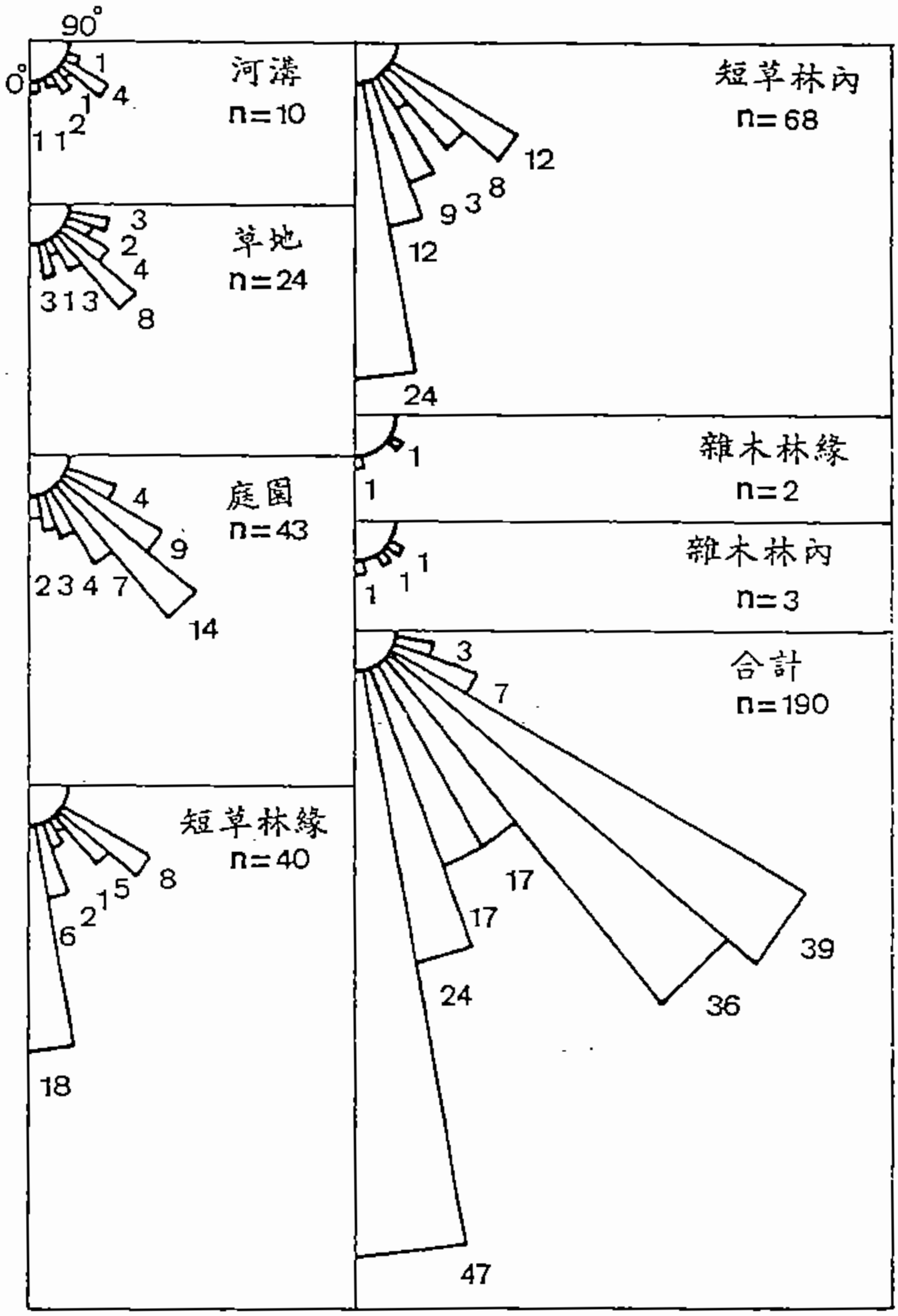
數值爲平均值±sd，單位是mm
（　）內爲測量隻數

表七　紅尾伯勞獵物之大小及種類

獵物長度（cm）	頻度	食物種類	頻度
<1	2127	雙翅目	6
1-2	28	膜翅目	10
2-3	24	同翅目	1
3-4	9	鞘翅目	10
4-5	6	鱗翅目	26
5-6	2	直翅目	19
6-7	0	蜻蛉目	4
7-8	0	蜘蛛綱	2
>8	4	蜈蚣	1
		白蟻	7
		蚯蚓	2
		蜥蜴類	7
		嚙齒類	1



圖四　紅尾伯勞捕食前棲枝高度之頻度分布



圖五　紅尾伯勞俯衝時與垂直線形成角度之頻度分布

緣地區因資料量太小，無法進一步分析比較）。以上結果顯示在植被較稀疏的地區，伯勞會以較大的俯角俯衝覓食，亦即在植被較稀疏地區，伯勞搜尋獵物時視力涵蓋的範圍較在植被濃密處寬廣。

伯勞俯衝攻擊獵物時，距獵物的直線距離最近低於0.5公尺，最遠是23.5公尺，最普遍的距離在1.5至3公尺之間（51.58%，n＝190，圖六）。平均直線距離由遠至近依序是河溝、草地、庭園、短草林內、短草林緣、雜木林緣及雜木林內。顯然在植物較稀疏的環境，伯勞會俯衝較長的距離捕食。

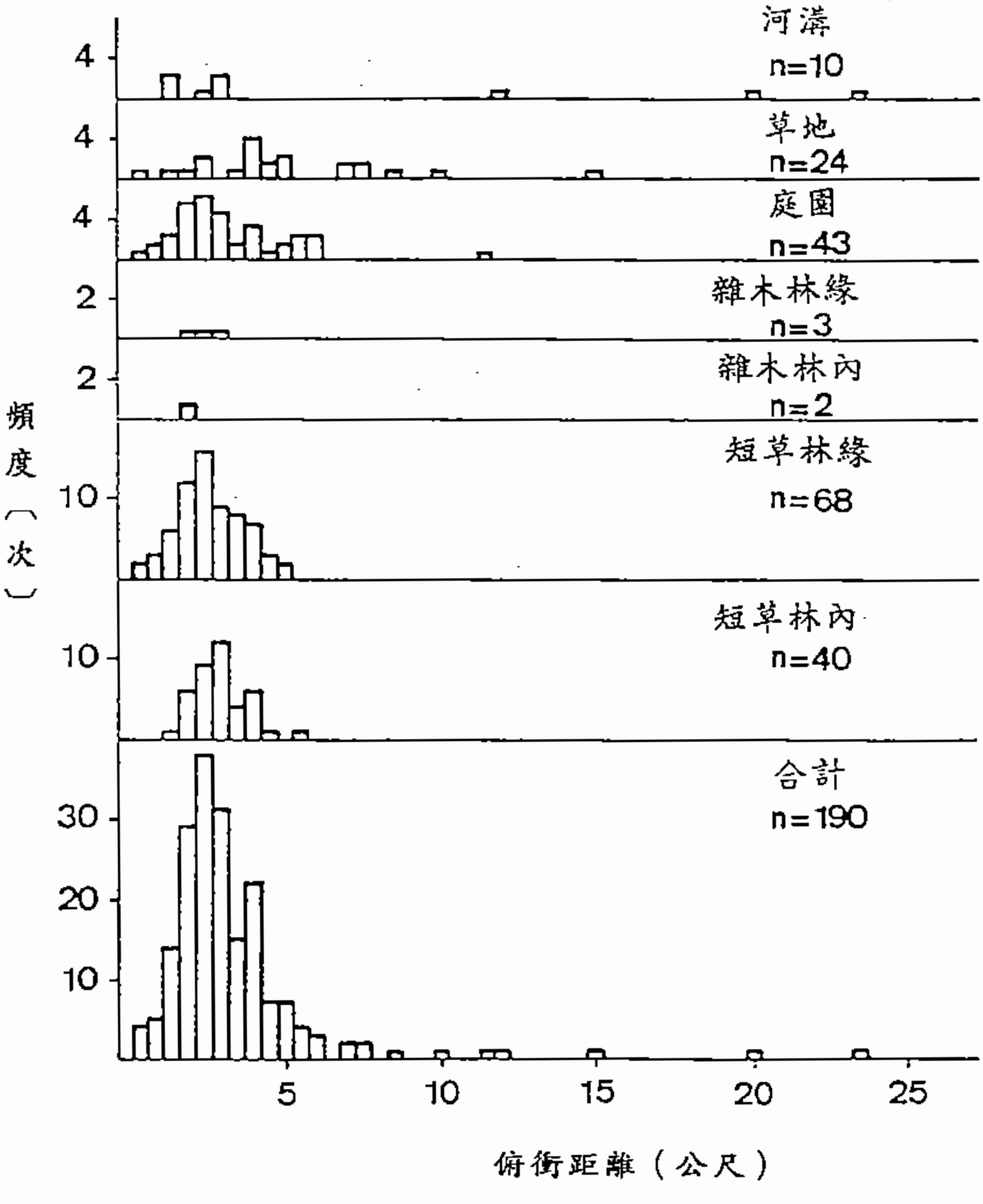
四、領域行爲

工作人員於79年度秋季在穿越線上見到許多次伯勞打架、追逐、及敵對性鳴叫（圖七），每日所見敵對性行爲或鳴叫之頻率，與當日穿越線上所見伯勞總隻數成正比，敵對行爲與數量之相關係數是0.54（n＝55，$p<0.001$），敵對鳴叫與數量之相關係數是 0.79（n＝55，$p<0.001$），顯示紅尾伯勞在秋過境期間也有相當強的領域性。76年9月7日曾見下述行爲：

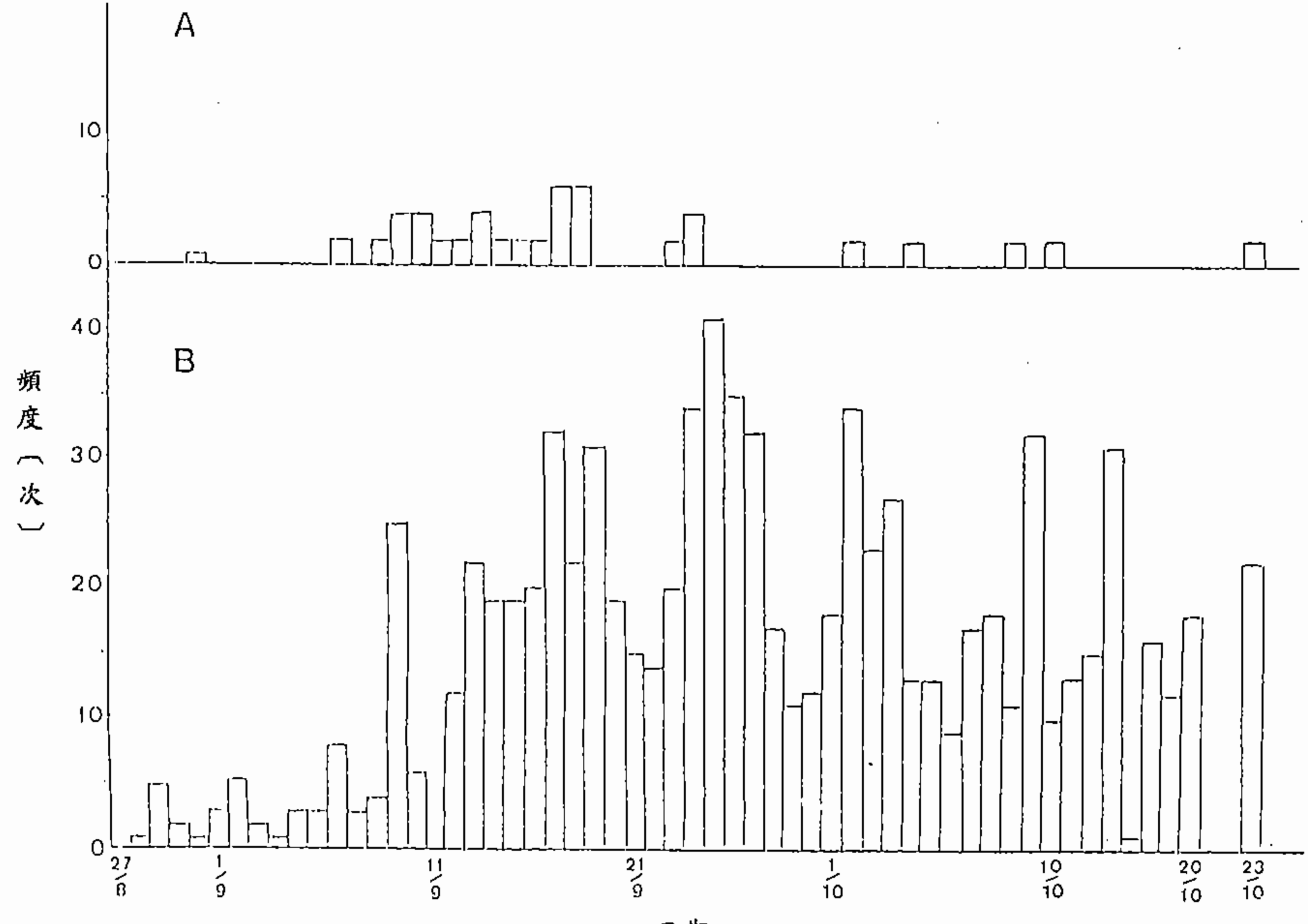
「0702-0719：第二區相思林緣見2隻紅尾伯勞，一隻是褐頭(A)，另一隻是灰頭(B)，2隻都在大青枝上，相距不遠。A先攻擊B，2隻追著飛，相距很近但並沒有接觸或打架。後B又攻擊A，追逐約5公尺就停下來。後來B向西移動約15公分，停在小相思樹頂，A站在原來枝上張望，並捕到一隻很小的昆蟲吃掉。0709時A開始嘎嘎叫。B也嘎嘎叫。A以短距離向西移，漸漸向B靠近，到達B停棲的相思樹時，慢慢向上跳。當2隻相距約30公分時B跳到北方枝上，使兩隻相距約50公分，但彼此相安無事，不久兩隻就分別飛入林中不見了。」

77年度從事全年全區觀察時所記錄的領域行爲，包括打架、追逐、對峙、互相威嚇展示、及對叫等。此類行爲出現之頻度以九月初及十月十三日至十一月九日之間最高，打架次數則以十月十三日至二十三日間所見三次爲最高（圖八）。

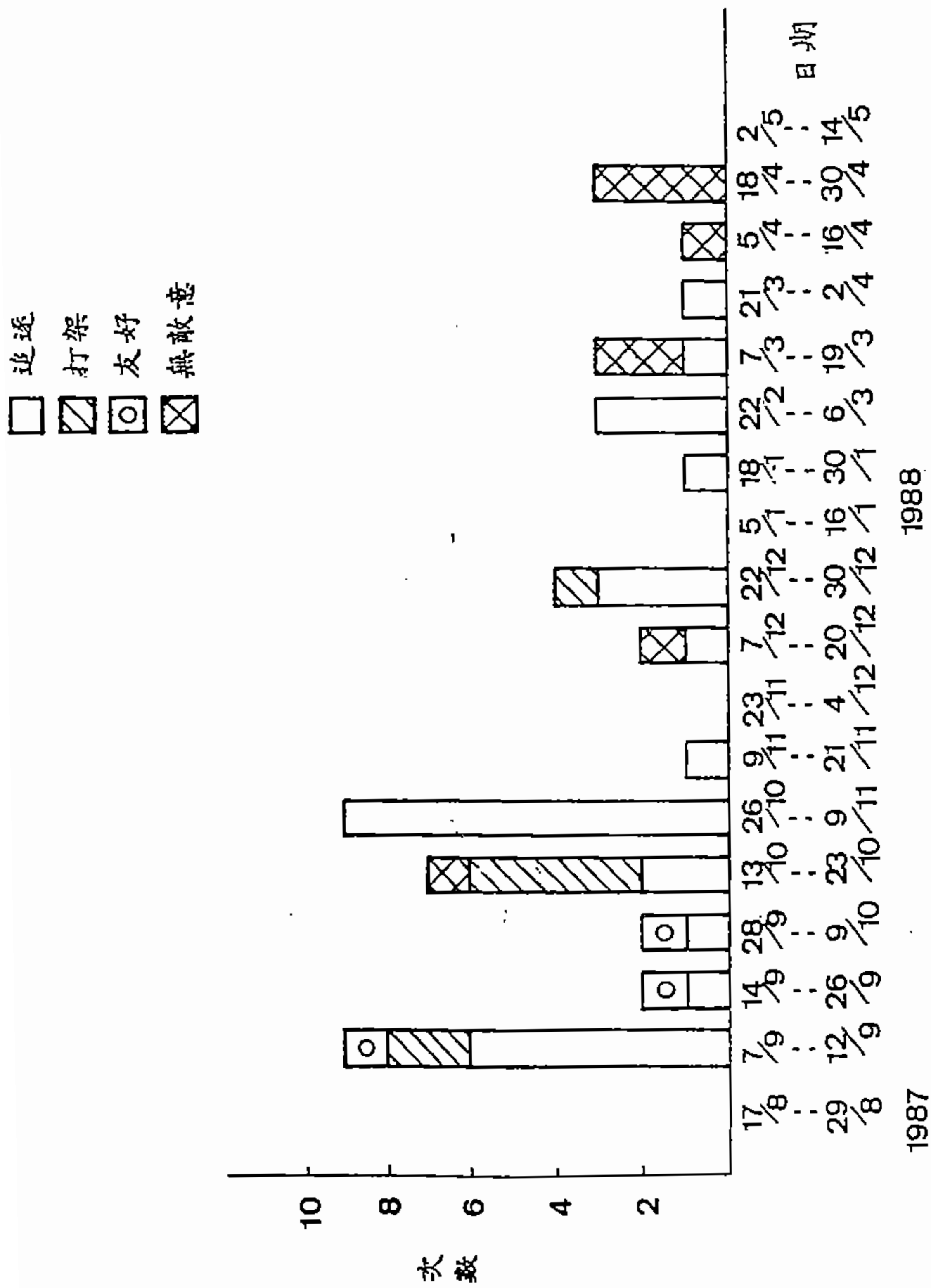
「紅尾伯勞打架通常相當激烈，多次都是見到 2隻在空中撕咬著，



圖六　紅尾伯勞獵食時俯衝距離之頻度分布



圖七　(A)穿越線上每日所見紅尾伯勞打架與追逐頻度
(B)每日聽見紅尾伯勞敵對鳴叫頻度



圖八　77年度紅尾伯勞敵對行爲及無敵意共處之頻度分布

由空中掉落到地面才分開，有一次2隻甚至在地面對峙約10秒鐘才各自飛走。也曾見一隻伯勞入侵到一個領域中，與地主相遇後2隻均飛到樹梢互相嘎嘎對叫，叫一陣後即在空中相撲撕咬墜落，落到半途入侵者飛離領域才結束。」

比較兩年中所見現象，若伯勞果然每年遷徙季節十分固定，則77年度所見九月初至十月初主要是過境鳥間之敵對行爲，十月中至十一月初是過冬鳥間的領域行爲。

春天候鳥北遷時，三年中僅見過三次領域行爲；此外79年 4月AA的領域內先後出現過兩次過境鳥，其中一隻曾於AA不在時發出領域叫聲，並追逐領域內之白頭翁，但AA出現後，即未再見過境鳥的蹤跡。

五、領域之界定與轉移

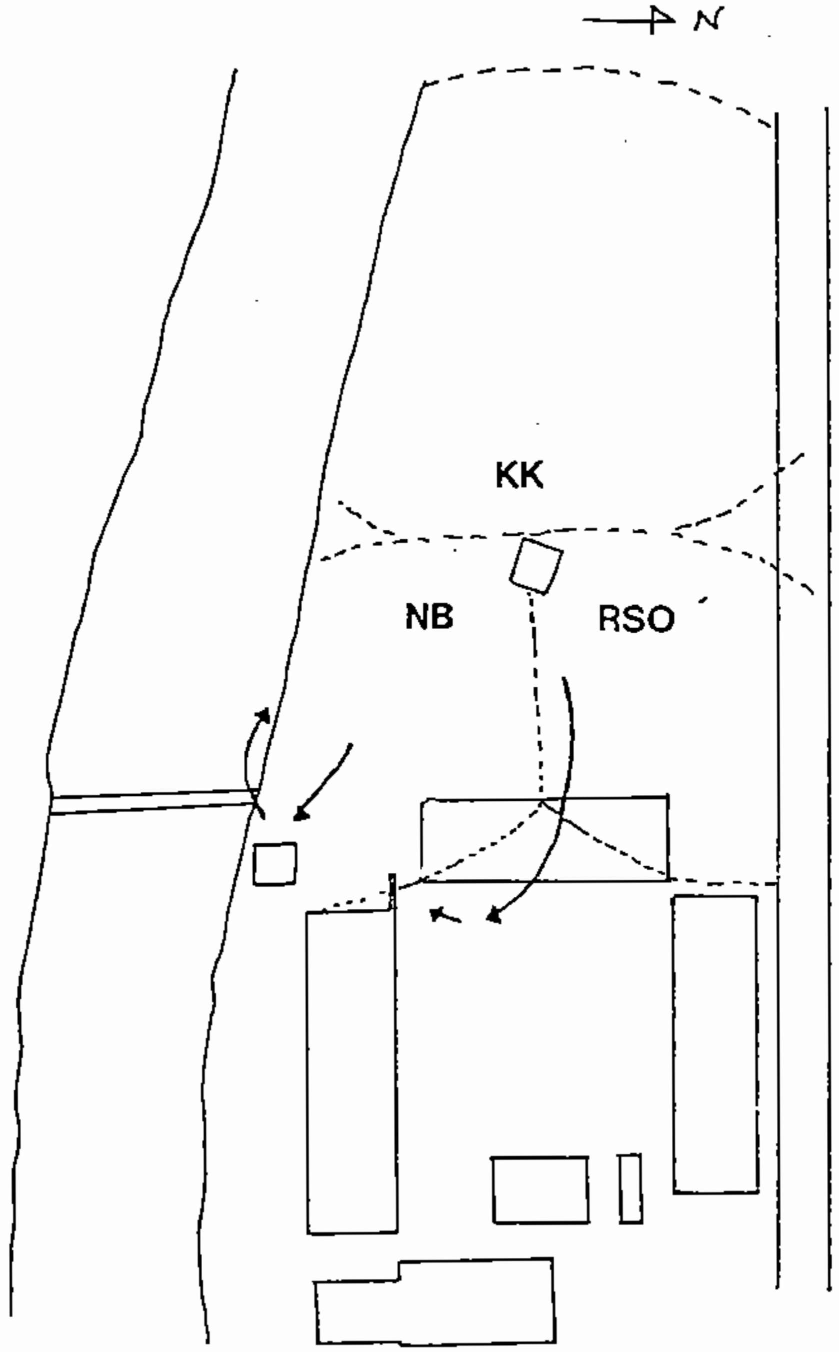
在76年10月28日，曾見下述領域界定過程：

「1540-1550：生物系西邊相思林中見3隻伯勞（RSO,KK,及NB）。RSO與KK打架，另一隻向南飛到河溝北岸，RSO與KK向東追逐約20公尺後停下來。稍後見3隻停在附近約1分鐘，後RSO與KK又追逐到約10公尺外，停在同一棵相思樹稍相距約60公分，RSO對著KK不斷如幼鳥乞食般振翅，並發出尖銳的嘎嘎叫聲，似在恐嚇KK，而KK保持不動。約30秒後，RSO跳向KK，10秒後二隻都飛走，但還是在同一棵樹上。7分鐘後又見二隻伯勞追逐。」

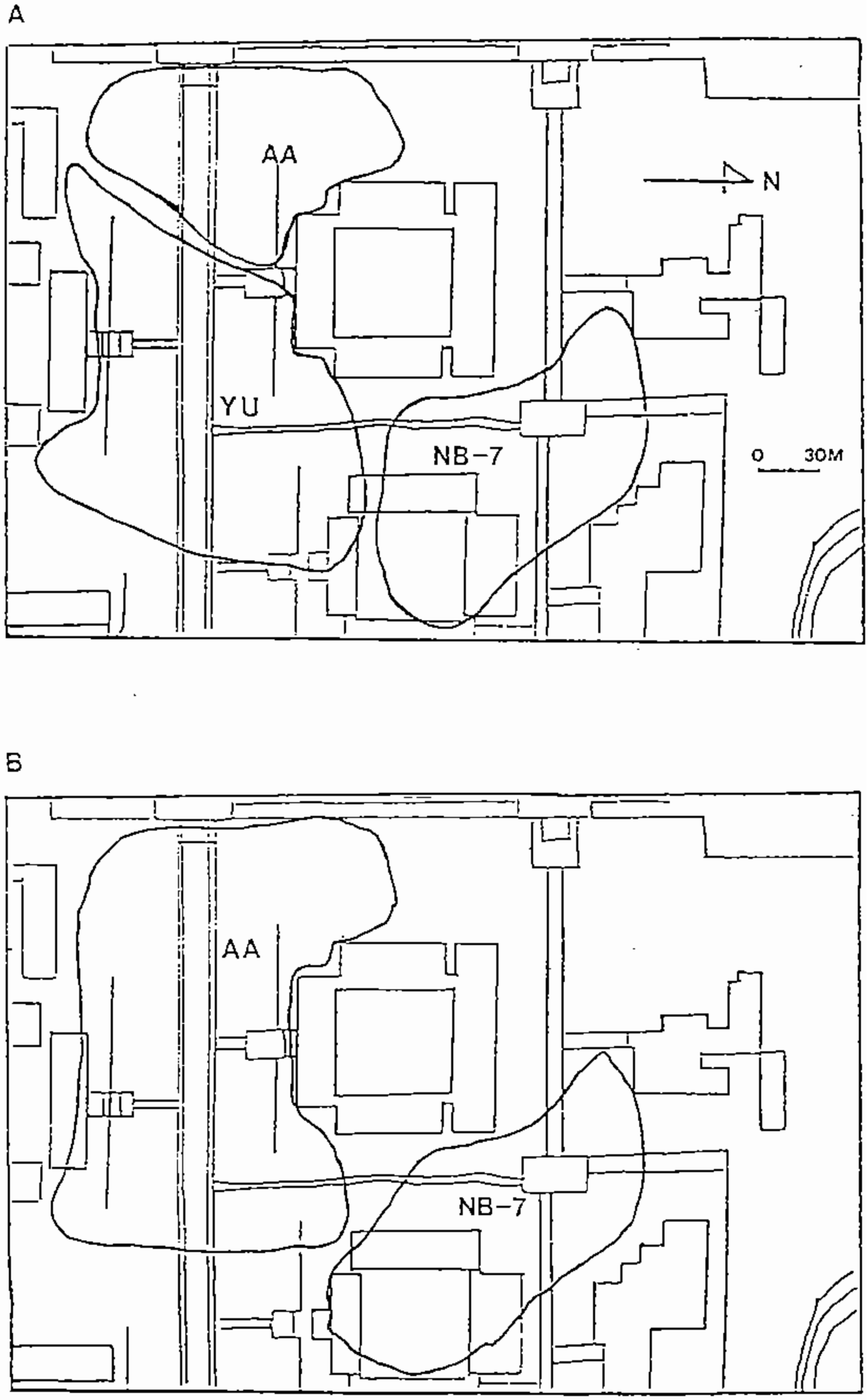
當日追逐路線與日後領域邊界相當吻合（圖九）。

過冬領域建立後，領域範圍便相當穩定，但是佔有領域的伯勞因故消失後，附近的伯勞便會擴張自己的領域，將空出的棲地瓜分，例如YU在79年1月消失後，AA及NB-7便將牠的領域分據部份爲己有（圖十）。此種現象也可能發生在春季，例如BB在5月初消失後，OWB,NB-39,及NB-77的領域便隨之擴張，分割了空出的棲息環境（圖十一）。

研究人員在77 年度共覓得76個領域，78 年度80個領域，79 年度116個領域。領域數量逐年改變的理由之一是78年度與79年度的觀察範

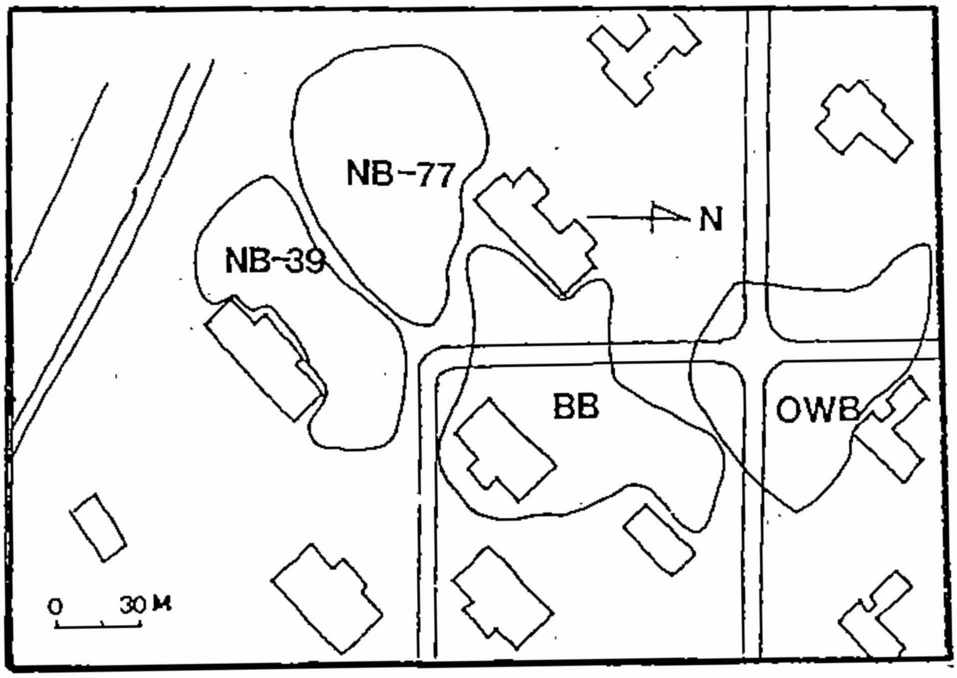


圖九　三隻伯勞間之敵對行爲及日後領域邊界

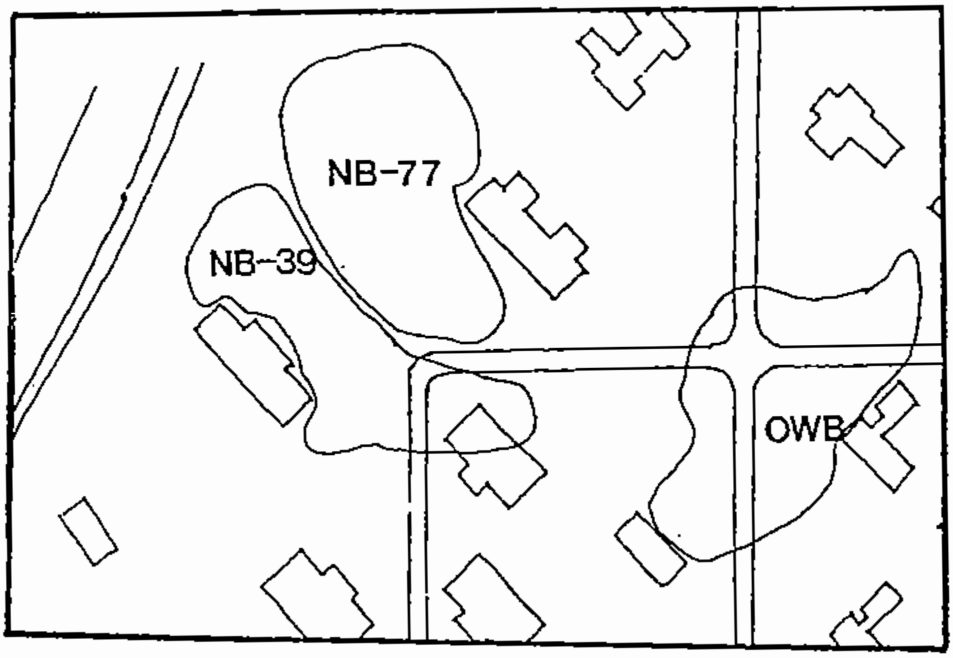


圖十　(A)1月22日YU消失前，相鄰三隻紅尾伯勞之領域範圍
(B)2月26日YU消失後，所餘兩隻伯勞之領域範圍

A



B



圖十一(A)79年4月四隻紅尾伯勞之領域範圍
(B)79年5月BB消失後，所餘三隻伯勞之領域範圍

圍稍微擴大，故在78年度有25個新領域，79年度有21個新領域，但78年度有14個舊領域完全未被利用，其中9個到79年度又被至少部份利用，而78年度的新領域中有8個在79年度則完全未被利用。

伯勞的領域常是緊緊相鄰的，因此在研究區中的分佈是區狀的，每一區中有數目不等的領域，在區與區間常是不適當的環境。分析三年伯勞領域之界限，見即使同一隻鳥回到同一地點過冬，各年領域之邊界也不儘相同（圖十二）。若將重疊度超過50%者定爲相近，有23個領域的位置三年均相近，42個領域有二年位置相近，28個領域的位置則轉移到只有小部份與往年重疊，或數個領域連續均轉移所以新領域可能與過去數個領域重疊。另外有10個原來面積較大的領域在78年度或79年度被分成二至四個。

六、伯勞對過冬領域之忠實性

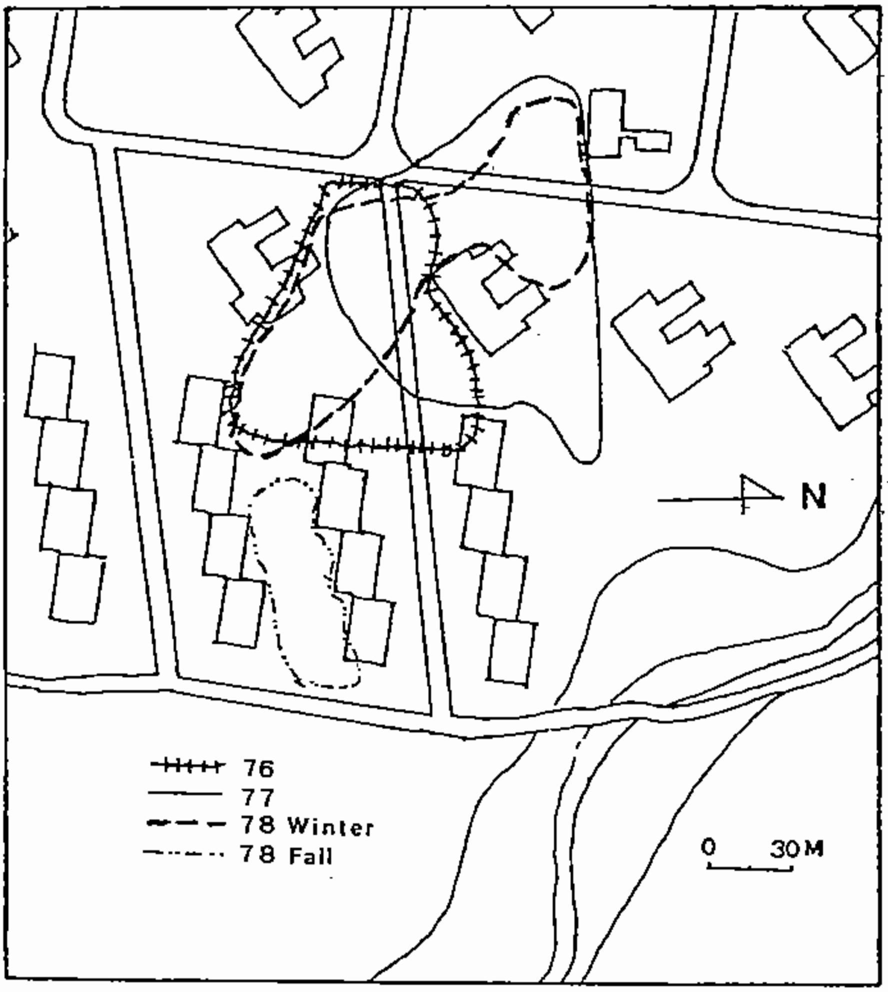
77年度共捕得51隻伯勞，其中25隻是渡冬鳥，26隻是過境鳥。此25隻過冬鳥中，有8隻於78年度回到原領域過冬，有8隻於79年度，3隻於80年度再度回到原地過冬。

79年度共捕得27隻伯勞，其中5隻是過境鳥，22隻是過冬鳥，包括一隻是77年度已標誌的鳥。80年度有4隻79年度繫放的鳥回到原領域或附近過冬。

沒有腳環標誌的個體所佔有的領域中，有10個歷年佔有者之外型相同，極可能是同隻鳥連續使用相同領域過冬。因此數年連續回到研究區使用相同領域過冬的隻數，所佔比例相當高。但78年10月2日也曾見到一隻76年之過冬鳥，在距原領域200公尺處活動，三天之後即不見蹤影，不知是已死亡，或是自77年起已在研究區外覓得其他過冬領域。

七、過冬伯勞設立領域之季節性

79年度只有六隻有腳環的過冬伯勞在秋過境期即已到達研究地區。這六隻之中有四隻一開始即在往年過冬領域上活動，UKU 並在到達當天即開始驅逐進入牠領域的過境鳥，但另一隻在秋天過境期之活動範



圖十二　76至78年SRK之過冬領域，及其78年秋季過境期之活動範圍

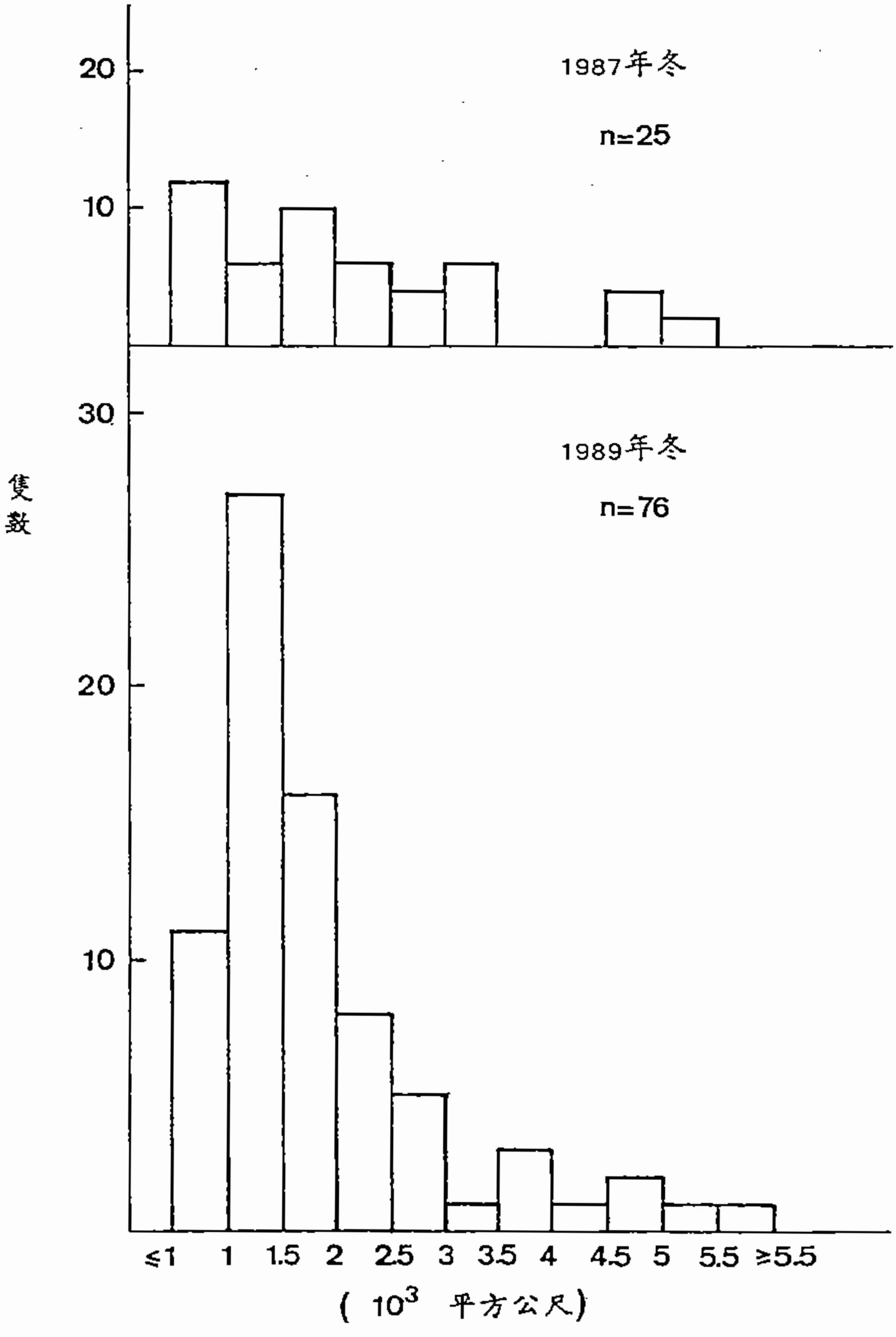
圍，卻與其過冬領域不同。此隻（SRK）在78年9月初剛抵達時，並未在前兩年過冬領域內出現，而是在領域東方相鄰地區活動，當時牠原有領域上有其他過境伯勞在活動，但過境期後，SRK的過冬領域又大致與過往的領域相同（圖十二）。

八、領域面積

77年度的過冬領域中面積最小的是410平方公尺，最大的是 6900平方公尺，以佔1000至1500平方公尺面積的領域最多，1500至2000平方公尺者其次（圖十三）。79年度所選定的25個領域之面積，由710平方公尺到5050平方公尺均有，並不特別集中在某種範圍內（圖十三）。

77年度之領域中有16個資料較完整，這16個領域之面積大小與建築物佔地大小無關，也與短草林或其他任何一種棲地之面積沒有明顯相關（表八）但這些領域之主要棲地形態大都是短草林。79年度選定之25個領域之主要棲地形態分布較平均，有4個領域主要是草地，8個主要是庭園，2個主要是河溝，9個主要是短草林，另有1個領域之棲地介於庭園及草地之間，雜木林僅出現在三個領域中，只在一個領域中是主要棲地（表九）。此25個領域中有十個屬於單一棲地類型（樹林邊緣與內部在此歸爲同型），其他都包含了數種類型，分析領域大小與棲地形態之關係時，發現總面積與領域中之草地面積成正比（ $r=0.706$，$p<0.001$，$n=24$），與其他棲地類型之面積則無關，即領域中草地面積愈大，其整個面積也愈大。因爲AA之領域中有81％之棲地是大片草地上有兩列行道樹及一些小型苗木，與其他領域形態均不同，故未列入此項分析。

以三角函數計算俯衝捕食時伯勞與獵物間的水平距離，可估計伯勞對其領域中各種棲地實際利用之範圍。結果發現伯勞捕食時，190次中有59.47%所移動的水平距離不超過1.5公尺（圖十四），但最遠可到22公尺。伯勞移動的水平距離也隨棲地之不同而改變，同樣以在開曠地區移動距離較遠。同時，伯勞移動之水平距離與捕食前之棲枝高度及俯衝俯角均有正相關（$r=0.84$，$n=190$，$p<0.001$；$r=0.58$，$p<$



圖十三　紅尾伯勞領域面積

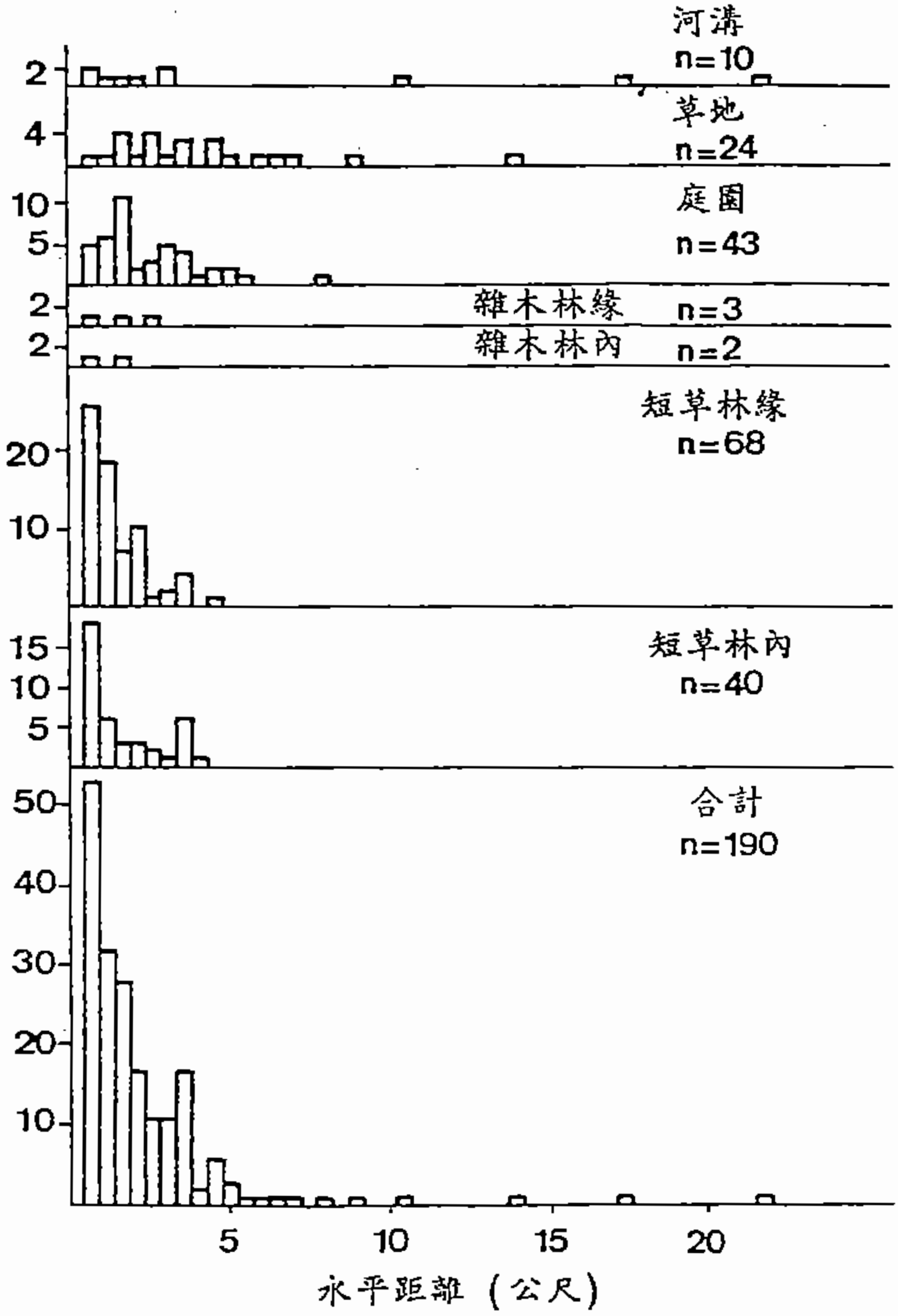
表八　77年度紅尾伯勞棲地型態分析

個體名	棲地面積（%）						總面積（m^2）
	雜木林	短草林	河溝	草地	建築	庭園	
RSO	30	50	0	10	10	0	1588.24
USR	15	55	0	15	15	0	1352.94
NBA	5	20	0	10	65	0	3647.01
UWU	0	50	0	10	30	10	2352.94
NBB	0	50	0	30	20	0	6911.76
RWB	5	10	2	50	33	0	4617.65
NBO	0	40	35	10	15	0	2676.47
KSU	5	40	0	30	20	5	4117.65
NB-CH	18	50	2	15	15	0	1000.00
UKU	10	55	0	15	20	0	2441.18
OWB	5	40	0	30	20	5	1205.88
NBD	10	20	65	0	5	0	2411.76
NBP	0	75	0	15	10	0	1705.88
WWW	8	90	0	1	1	0	2705.88
NB1	6	32	23	18	4	17	3852.94
NB2	0	63	31	3	3	0	3000.00

表九　79年度渡冬伯勞領域內各種棲地面積

領域	總面積	雜木林內	雜木林緣	短草林內	短草林緣	河溝	庭園	草地	修正後總面積
NB-I	5048.9	0.0	0.0	0.0	0.0	0.0	566.9	4482.0	3811.5
AA	4979.5	0.0	0.0	486.5	458.4	0.0	4034.6	0.0	4569.9
NB-L	4506.7	0.0	0.0	0.0	0.0	0.0	751.7	3755.0	4506.7
NB-B	3362.2	0.0	0.0	1769.1	477.8	0.0	0.0	1115.3	3288.7
ARA	3236.8	0.0	0.0	348.1	352.4	231.4	2304.9	0.0	3236.8
NB-J	3195.4	0.0	0.0	0.0	0.0	0.0	0.0	3195.4	3195.4
SRK	2948.9	0.0	0.0	0.0	0.0	0.0	2948.6	0.0	2948.9
UKU	2575.1	0.0	0.0	2044.5	367.6	0.0	163.0	0.0	2575.1
NB-E	2344.4	0.0	0.0	2344.4	0.0	0.0	0.0	0.0	2344.4
NB-F	2296.2	0.0	0.0	657.3	601.1	1037.8	0.0	0.0	2296.2
NB-G	2192.4	0.0	0.0	1537.3	655.1	0.0	0.0	0.0	1032.3
NB-H	1928.9	0.0	0.0	0.0	0.0	0.0	333.3	1595.6	1848.1
BB	1907.0	0.0	0.0	0.0	0.0	0.0	1907.0	0.0	1907.0
NB-C	1815.6	0.0	0.0	0.0	0.0	666.7	811.1	337.8	1815.6
NB-K	1713.8	0.0	0.0	0.0	0.0	0.0	1238.2	475.6	1713.8
WR	1697.3	0.0	0.0	0.0	0.0	0.0	1697.3	0.0	1697.3
OBS	1457.3	462.7	170.8	0.0	302.7	521.1	0.0	0.0	1457.3
RSO	1277.9	0.0	0.0	320.1	352.4	0.0	605.4	0.0	1277.9
OWB	1007.6	0.0	0.0	0.0	0.0	0.0	1007.6	0.0	1007.6
NB-M	988.9	0.0	0.0	451.1	537.8	0.0	0.0	320.0	988.9
KUKU	968.6	0.0	0.0	720.0	248.6	0.0	0.0	0.0	968.6
NB-D	957.8	0.0	0.0	0.0	0.0	565.7	0.0	392.1	957.8
OWO	838.9	0.0	0.0	358.9	480.0	0.0	0.0	0.0	838.9
NB-A	831.9	2.1	84.3	481.7	263.8	0.0	0.0	0.0	831.9
BRW	711.3	2.2	84.3	326.5	298.3	0.0	0.0	0.0	711.3
合計	54789.3	467.0	339.4	11845.5	5396.0	3022.7	18369.9	15348.8	51827.9

單位：平方公尺



圖十四　紅尾伯勞覓食時所移動之水平距離頻度分布

0.001)。

根據此種分析及各領域之棲地群圖，可計算出各伯勞領域中可能被利用之最大面積，發現25個領域中有5個並不能完全被利用，因爲庭園或草地上之棲枝間距離太遠不能全部涵蓋。將此五個領域中伯勞無法利用的面積扣除後，再分析面積與各種棲地形態的關係，發現領域面積仍是只與草地面積呈正相關（r＝0.736，n=24，p＜0.001）。

根據目前所知，各伯勞領域面積之大小，與伯勞抵達過冬地點之日期無關，也與各伯勞之體重或外型尺吋無關，並無先到者領域較大，或體型較大者領域較大等現象。但因資料量很少，仍待進一步求証。

九、領域特色及棲地利用

伯勞對其領域內的各種棲地，除少數例外，都會加以利用，連建築物也是重要停棲覓食的位置（表十）。分析伯勞在不同環境中活動的時間比例，可見伯勞主要是在樹林中活動，尤其是短草林。77年度雖然數個領域中有相當面積的河溝與草地，伯勞在其中活動的時間卻普遍很低，在庭園中活動的時間比例與庭園所佔面積比例相近。79年度伯勞在庭園與草地上活動的時間比例低於這兩種棲地所佔面積之比例，而在河溝的時間比例卻高於面積比例。即使只考慮79年度有多種棲地的13個領域（因此種領域中的伯勞才有選擇棲地的機會），伯勞仍然最常利用短草林，對其他棲地之利用狀況與前所述相同，僅在草地上的時間比例與草地所佔面積比例相近（表十一）。

77年度伯勞由不同棲地中所獲相對食物量，平均以在短草林緣比率最高（48.8%），短草林內其次（22.7%），在密林緣則不是很成功即很不成功（表十二）。79年度之結果，當排除只有單一棲地形態的領域時，以在草地上之平均所獲食物比率最高（49.86%），在短草林緣其次（43.63%），庭園中第三（35.96%）。伯勞由各棲地獲得之食物量各領域間變異很大，僅在短草林中較爲穩定（表十二）。

根據昆蟲採集的結果，不同棲地及不同領域間之平均單位面積昆蟲量均不相同，但各領域間之差別不顯著（變異數分析，P＞0.10），

表十　77年度紅尾伯勞在不同棲地活動時間百分比

個體名	棲地（觀察時間%）								觀察時間（分）	
	雜木林（內）	雜木林（緣）	短草林（內）	短草林（緣）	河溝	草地	建築	庭園	總合	平均
RSO	20.8	32.7	9.5	32.3	-	0.3	4.4	-	328.4	5.5
USR	4.6	39.6	7.9	40.9	-	3.7	3.3	-	214.8	3.3
NBA	0.0	0.0	20.5	76.0	-	0.0	3.5	-	171.0	5.9
UWU	-	-	9.7	47.7	-	0.0	3.9	38.7	77.5	3.5
NBB	-	-	11.0	56.9	-	6.0	26.1	-	141.5	4.3
RWB	0.0	2.5	0.0	67.7	0.0	8.7	21.1	-	80.5	8.9
NBO	-	-	34.6	62.0	2.5	0.0	0.9	-	160.5	3.2
KSU	3.6	2.2	32.2	40.6	-	1.4	14.5	5.5	138.0	4.2
NB-CH	0.0	0.0	2.3	78.0	4.0	0.0	15.7	-	111.5	3.7
UKU	0.0	0.0	50.3	44.0	-	0.0	5.7	-	95.5	2.6
OWB	0.0	0.0	10.0	71.7	-	0.0	5.0	13.3	60.0	1.8
NBD	7.5	55.7	2.8	25.5	8.5	-	0.0	-	53.0	5.3
NBP	-	-	70.2	29.2	-	0.0	0.6	-	159.5	4.2
WWW	0.0	7.0	24.4	67.5	-	1.0	0.0	-	197.0	3.5
NB1	0.0	1.0	55.9	3.2	23.4	0.0	0.0	16.5	94.0	2.1
NB2	-	-	21.3	22.7	55.3	0.7	0.0	-	70.5	2.8

表十一　紅尾伯勞在不同棲地中覓食時間與棲地面積之比較

年　項　目	棲	地						
	短草林內	短草林緣	雜木林內	雜木林緣	河　溝	庭　園	草　地	建　築
1987								
面積（％）	--43.33--		--5.42--		9.72	2.54	19.23	19.77
覓食時間（％）	22.85	48.09	4.04	11.23	3.43	2.84	1.34	6.17
1989								
面積（％）*	20.62	10.41	0.90	0.65	5.83	34.65	26.93	-
覓食時間（％）	12.84	23.58	1.97	2.98	9.82	29.71	16.17	-
1989（不包括僅有單一棲地之領域）								
面積（％）*	25.16	14.60	1.86	1.35	12.02	19.03	25.98	-
覓食時間（％）	12.59	28.82	3.33	5.03	16.60	6.30	27.33	-
Chi-square=1299.005, df=6, P<0.0001**								

*　此面積為修正過者，不包括無法利用之面積，詳見結果之九

**　卡方分析利用原始資料，未列於表上

表十二　紅尾伯勞在不同棲地中所獲平均相對食物量

年　項目	棲地							
	短草林內	短草林緣	雜木林內	雜木林緣	河溝	庭園	草地	建築
1987								
(n=16) 所獲平均	22.70	48.80	0.92	13.26	5.77	15.20	3.19	8.99
相對食物量(%)	(24.4)	(19.4)	(3.05)	(21.14)	(8.02)	(13.41)	(5.86)	(13.50)
1989								
(n=20) 所獲平均	30.12	42.88	12.33	18.57	38.63	65.76	49.86	-
相對食物量(%)	(19.05)	(21.99)	(10.99)	(17.89)	(38.85)	(36.08)	(34.73)	-
1989(不包括僅有單一棲地之領域)								
(n=14) 所獲平均	28.88	43.63	12.33	18.57	38.63	35.96	49.86	-
相對食物量(%)	(18.35)	(22.21)	(10.99)	(17.89)	(38.85)	(24.71)	(34.73)	-

( )中爲標準差

而各棲地間之差異卻顯著（變異數分析，P＜0.05，表十三）。只考慮有多種棲地之領域時，河溝及雜木林內部之平均單位面積昆蟲量最高，雜木林緣其次，庭園及短草林緣第三，短草林內部及草地上之昆蟲量較少。單一形態之棲地上之昆蟲量，多比此平均值要低（表十三）。

若比較伯勞在各棲地覓食之時間，及在各棲地中所獲之食物量，可見伯勞在各棲地之相對收穫，與在該棲地停留時間比例相近，然而伯勞在各棲地停留時間並不與該棲地所佔面積相關，顯示伯勞對棲地之利用有選擇性。

若分別比較每隻伯勞在自己領域中不同棲地上停留之時間，與各棲地中平均昆蟲量，可見68.75%（n＝16）之伯勞均在昆蟲最多之棲地中停留最久；此外，有一個領域中各種棲地中昆蟲量相近，伯勞（NBA）在各種棲地中停留時間也相近，另有一領域中各種棲地中昆蟲量相近，但棲地面積相差很大（1：4.5），伯勞(NBH)在面積大之棲地中停留時間較久；僅有三個領域（18.75%）之伯勞對棲地之利用未反應昆蟲量之多寡（表十四）。

比較76年與78年均在研究地區過冬的兩隻伯勞，見兩隻鳥在78年對棲地之利用均增加了庭園並提高了短草林緣所佔的比例，表示各隻伯勞對棲地之利用並不固定，而可能會隨食物之多寡而轉移。

伯勞領域之大小與每領域之平均昆蟲量無關。與各伯勞之覓食效率（每分鐘捕食次數）無關，也與各棲地總昆蟲量（面積×單位面積昆蟲量）無關。所以並非食物多之領域面積較小，也非效率高的個體領域較小，不過覓食效率越高的個體其領域內的昆蟲量有越少的趨勢，只是此趨勢並不顯著（r＝－0.4，n＝20，p≒0.08）。

討　　論

紅尾伯勞南遷到達大度山時數量相當集中，同時其季節性在年與年間變異很小。這種現象在恆春地區也見到，由當地過境的伯勞每年都是在白露前後到達（Severinghaus，1968，及個人觀察），也因此

表十三　各領域不同棲地中之昆蟲量

鳥名	短草林內	短草林緣	雜木林內	雜木林緣	河溝	庭園	草地	平均±sd
AA	0.0033	0.0037	-	-	-	0.0065	-	0.0057 ±0.0058
ARA	0.015	0.014	-	-	*	0.014	-	0.014 ±0.0081
BB	-	-	-	-	-	0.012	-	0.012 ±0.01
BRW	0.018	0.011	*	0.0013	-	-	-	0.012 ±0.016
KU	0.0039	0.0078	-	-	-	-	-	0.0055 ±0.0054
NB-A	0.012	0.011	*	0.010	-	-	-	0.011 ±0.015
NB-B	0.0038	0.0017	-	-	-	-	0.0046	0.0041 ±0.0028
NB-C	-	-	-	-	0.015	0.006	0.004	0.011 ±0.014
NB-D	-	-	-	-	0.0081	-	0.0056	0.0076 ±0.0063
NB-F	0.0073	0.017	-	-	0.022	-	-	0.014 ±0.016
NB-G	0.0023	0.012	-	-	-	-	-	0.0099 ±0.023
NB-H	-	-	-	-	-	0.015	0.010	0.011 ±0.011
NB-I	-	-	-	-	-	0.017	0.019	0.017 ±0.015
OBS	-	0.018	0.019	0.044	0.032	-	-	0.026 ±0.029
OWB	-	-	-	-	-	0.0067	-	0.0067 ±0.0044
OWO	0.0063	0.010	-	-	-	-	-	0.0087 ±0.011
RSO	0.0020	0.016	-	-	-	0.0081	-	0.0085 ±0.0086
SRK	-	-	-	-	-	0.0073	-	0.0073 ±0.0073
UKU	0.0072	0.0033	-	-	-	0.015	-	0.0080 ±0.0076
WR	-	-	-	-	-	0.0093	-	0.0093 ±0.0065
@平均±sd	0.0085 ±0.0052	0.012 ±0.056	0.019 -	0.018 ±0.022	0.019 ±0.010	0.013 ±0.0058	0.0086 ±0.013	

說明　* 未採樣
@計算平均時未包括單一棲地及AA之領域在內
各領域間變異度分析 F=1.39，P=0.108
各棲地間變異度分析 F=2.4 ，P=0.048

表十四　各領域不同棲地間昆蟲量，面積，及伯勞覓食時間之比較

鳥名	棲地	面積 (m²)	昆蟲量 (克／m²)	覓食時間 (分)	鳥名	棲地	面積 (m²)	昆蟲量 (克／m²)	覓食時間 (分)
(AA)	短草林內	486.5	0.0033	7.5	(NB-B)	短草林內	1769.1	0.0038	6.5
	短草林緣	458.4	0.0037	44		短草林緣	477.8	0.0017	112.8
	庭園	3625.0	0.0065	178.5		草地	1041.8	0.0046	377.8
(ARA)	短草林內	348.1	0.015	51.2	(BRW)	短草林內	326.5	0.18	103.8
	短草林緣	352.4	0.014	45.3		短草林緣	298.3	0.011	52.5
	庭園	2304.9	0.014	24.9		雜木林內	2.2	-	78.2
	河溝	231.4	-	15.5		雜木林緣	84.3	0.0013	87.0
(KU)	短草林內	720.0	0.0039	129.65	(NB-D)	河溝	565.7	0.0081	309
	短草林緣	248.6	0.0078	137.2		草地	392.1	0.0056	6
(NB-A)	短草林內	481.7	0.012	129.7	●OBS	短草林緣	462.7	0.018	101.6
	短草林緣	263.8	0.011	137.2		雜木林內	170.8	0.019	16
	雜木林內	2.1	-	?		雜木林緣	302.7	0.044	27.8
	雜木林緣	84.3	0.10	?		河溝	521.1	0.032	94.5
●NB-C	河溝	666.7	0.015	6.5	(NB-F)	短草林內	657.3	0.0073	10
	庭園	811.1	0.006	70		短草林緣	601.1	0.017	26
	草地	337.8	0.004	10		河溝	1037.8	0.022	106.8
(NB-G)	短草林內	1537.3	0.0023	104.3	NB-H	庭園	333.3	0.015	12.2
	短草林緣	655.1	0.012	264.1		草地	1514.8	0.01	307.7
(NB-I)	庭園	566.9	0.017	60	(OWO)	短草林內	358.9	0.0063	134.7
	草地	3244.6	0.019	175		短草林緣	480.0	0.01	172.2
(RSO)	短草林內	320.1	0.02	8	●UKU	短草林內	2044.5	0.0072	28.2
	短草林緣	352.4	0.016	147.7		短草林緣	367.6	0.0033	131.3
	庭園	605.4	0.0081	30.8		庭園	163	0.015	4
BB	庭園	1907.0	0.012	220.5	OWB	庭園	1007.6	0.0067	378
SRK	庭園	2948.9	0.0073	305.5	WR	庭園	1697.3	0.0093	504

鳥名之（　）表示該個體在昆蟲多之棲地中覓食時間也多
●表示覓食時間不反應昆蟲量者

恆春人叫紅尾伯勞爲「白露兒」。實際上各地的紅尾伯勞可能是同時開始由生殖地南遷的，因爲每年東南亞各地伯勞渡冬區中幾乎都同時有伯勞出現(Lord Medway，1970)，而不是由北向南逐漸有伯勞到達。

春季伯勞北返時，大度山上並無大批候鳥過境的現象，而是零星過境，及過冬鳥先後離去。馬來半島上的渡冬伯勞自二月底至五月初北移（Lord Medway 1970），大度山上的伯勞主要是三月中至五月中北移，尤其集中在四月中至五月初期間。

部份渡冬鳥在遷徙季節中期即到達大度山，並且立即設立領域，但最早到達的那隻渡冬鳥，卻於到達後先在附近活動，等遷徙季節結束後才回到渡冬地點設立領域。這種差異不知是因⑴後者到達時原渡冬領域已被其他過境鳥佔用，⑵渡冬鳥會因年齡或性別不同而展現不同的領域性，或⑶個體差異。因有關此方面的資料不足，仍無法判斷。不過此隻鳥在渡冬區停留時間最久（共235天），同時已連續三年均回來渡冬，可能這種等到競爭壓力較小才設立領域，避免在過境期爲驅逐大量短期入侵者而疲於奔命的情形，是較具適應性的策略。

因渡冬鳥是零星離去的，少數春過境鳥可以利用空出來的領域停留一段時間再北移，加上此時過冬鳥多也已準備離去，可能因此領域性較低，四月以後雖數隻伯勞在鄰近地區出現，卻多能相安無事。

但79年五月初筆者至東沙島從事鳥類調查時，正逢大量伯勞過境，過境鳥間可見許多敵對行爲，包括對叫、追逐、搶棲枝等，顯然研究區中未見領域行爲並非因爲紅尾伯勞在春過境期對其他個體沒有敵意，而可能是因⑴過冬鳥在過冬地區之行爲與過境鳥有別，或⑵因沒有大量候鳥侵入，不需展示領域行爲之故。此部份之問題需在有過冬鳥及大量春過境鳥之地區去尋求答案。

研究人員捕捉到過境鳥的地點，實際上多已是渡冬鳥的領域。隨著季節的推進，過境鳥活動地區已被愈來愈多的渡冬鳥佔據爲領域。過境鳥很可能是以取巧的方法趁渡冬鳥不注意時分享牠的資源，但相遇時則立即逃離，因此能與領域主人「共處」。過境鳥也會維持移動

性的小型覓食領域（個人觀察；邱，1986），彼此之間也會展現領域行爲，當過境隻數多時，領域宣告與追逐頻繁，也因此在過境期所見敵對行爲頻度與族群數量成正比。

紅尾伯勞對過冬領域的忠實性很高。雖然因爲有腳環的鳥數目有限，無法判定實際重回研究區的個體數，但在有腳環的鳥中第二年重複回來的比例在26.9－36.4％之間。McClure（1974）也提到一隻紅尾伯勞連續五年均回到曼谷同一個花園過冬的現象。這種對領域的忠實性，不但減少個體間的爭奪展示需要，也減少了領域界限的變動性。可能也因此渡冬鳥的領域不曾因過境鳥的活動或離去而有大幅度的改變，在春天也僅有少數領域有擴大的現象。Winker等（1990）更指出使用同一過冬領域可增加個體對領域的熟悉程度，提高生存的可能。

根據紅尾伯勞在大度山過冬地區的棲地利用狀況，可見這種鳥是適應性很強的。牠們不但能隨棲地不同而改變捕食方法與行爲，也能測知不同棲地中食物量的多寡而優先利用食物豐富的地點。

各伯勞領域中之棲地分布狀況均不同，伯勞在不同棲地中之捕食效率也不同，但其中之差異應多是地區性食物量不平均，或個體捕食能力不同所造成。雖然研究人員只估計了各領域中無脊椎獵物之量，而未估計蜥蜴等之數量，但已可看出獵物在各領域之分布數量有別，而在各種棲地形態間之差異更明顯。然而在食物量少之領域中捕食之伯勞不一定收穫量即少。例如只有庭園的四個領域中昆蟲量均相當低，但WR的覓食效率是20隻伯勞之冠，而SRK也排名第九。

若伯勞對過冬領域之棲地形態具有選擇性，不同領域間之差異可能受下列因素的影響⑴生殖地之棲地狀況，⑵個體之性別，⑶個體之年齡或其他影響競爭能力之因素。紅尾伯勞繁殖地區東自琉球，西至中國中部，涵蓋廣大的面積與多種棲地類型；目前有關伯勞在繁殖區之資料極少，要解答此問題更需數國合作推動大規模之伯勞繫放及個體追蹤方可。

伯勞僅在繁殖季節成對活動，非繁殖季時各自設立領域過冬。

Morton等（1987）發現hooded warblers在過冬地點雌雄兩性會在完全不同的棲息環境中設立領域。伯勞是否也有分用棲息環境的現象，有待進一步研究。

紅尾伯勞的領域大小相差很多，此種大小與伯勞到達之日期、體重、當地昆蟲量、個體之覓食效率等均無關。可能如Reid及Weatherhead（1988）所見，領域之邊界認定，受地面物如地形、或棲枝等之影響，此等物件一方面協助劃分領域，也使領域之邊界較易於防禦。

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CURRENT STATUS OF FORMOSAN SILA RESTORATION PROGRAM

Ying Wang

Abstract. Formosan Sika (Cervus nippon taiouanus) was considered to be extinct in the wild. A restoration project was carried out to restore this species back to its natural habitat. In Nov. 1986, 22 deer (5 males) were selected from Taipei Zoo to start the operation at Shetin, Kenting National Park. That more than 60 deer were counted in Nov. 1990 at Shetin indicates that deer are very adaptive to their new environment and produce well. The final release of these rehabitated deer to other suitable habitats will be undertaken in the near future and the conflict between the welfare of the deer and local residetns will be inevitable. Thus, how to develop a balance plan to manage the deer will become a future challenge of this project.

梅花鹿的復育現況

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中文摘要

台灣梅花鹿（*Cervus nippon taiouanus*）復育計畫之目的在使野外已絕種之梅花鹿藉由現存飼養鹿群的野放，能重返山林。自民國73年開始進行各項準備工作及收集基本資料，於75年11月自台北動物園選取22頭鹿 5雄17雌以為復育核心鹿群，遷入墾丁國家公園內社頂復育區正式展開復育工作。至80年 1月鹿群已增至60隻以上，分別生活於復育區內不同地點之天然環境中，繁殖情形良好。此一現象顯示台灣梅花鹿適應力強，在未來野放的過程中，對新環境之適應當不致有太多的困難。然因其本身所具有之經濟價值而遭至人的覬覦，及其對植栽所可能造成的影響則是未來鹿群野放後所面臨的難題。欲解決此一難題，加強對大眾之保育教育及實施合理之狩獵制度，應為解決此一問題的可行之道。

一、緒　言

台灣梅花鹿是台灣特有亞種，屬於偶蹄目、鹿科、花鹿屬，是梅花鹿13個亞種中體型較大者（Whitehead ，1972）。在三、四百年前，台灣中低海拔的平原和丘陵地常可見到梅花鹿的活動，是先民和原住民主要經濟活動來源，對於先民和原住民的生活方式和經濟型態影響很大。然近年來，由於居民無限制的捕捉和因農地開發造成棲地受破壞，導至野外梅花鹿族群銳減。據 McCullough（1974） 於民國62年在台灣進行之調查報告中指出，野生台灣梅花鹿可能已於民國58年在野外絕跡，但在動物園和民間鹿場仍飼養不少的梅花鹿（施，1984）。

近年來生態保育工作在國際間極受重視，台灣梅花鹿亦被國際自然保育聯盟（IUCN）列爲世界受破壞和瀕臨絕種的鹿種之一，或謂台灣民間目前仍飼養有相當數量的梅花鹿，未達瀕臨絕種的地步，然民間鹿場養鹿多基於經濟效益，或有與其他種雜交的可能，影響本土固有的品系；此外飼養的族群，其野外特徵和求生本能或有所改變，一旦環境變動，可能會導至目前族群之衰敗或滅亡，因此如何利用現有飼養族群恢復其野性，保持其原有品系，應是復育工作的重點，同時更希望藉著復育工作之推行，能促進國人對野生動物保育的重視，並喚起大眾對我們自然環境的愛護。

梅花鹿復育計畫的構想是由已故的東海大學甘愫善博士(Dr. S. Lee Campbell)於民國七十二年提出，當時獲得亞洲協會謝孝同博士之贊同，並經內政部營建署張署長隆盛先生，行政院張政務委員豐緒先生及中華民國自然生態保育協會之支持與協助，當時邀請了國內各界相關專家組成台灣梅花鹿復育研究小組，做爲執行復育研究計畫之核心，於是本計畫乃根據行政院核定的台灣地區自然生態保育方案擬定，委請內政部營建署墾丁國家公園管理處主辦。

二、目　　標

台灣梅花鹿復育研究計畫之宗旨乃在保存台灣梅花鹿之固有品系，使其回復野性，重返山林。並希望藉此復育的過程建立一套復育的模式，做爲日後其它復育研究的參考，同時更希望因此喚起國人重視生態保育，明瞭梅花鹿與自然環境的關係及其與台灣歷史之淵源，提昇國人對此種大型研究之認知與重視，並藉此加強與國外之學術交流。此復育計畫爲國內首次進行之大型野生動物復育計畫。涉及行政、研究及管理的層面，茲將有關的成員逐一敘述於後：

1. 復育研究小組：爲畜牧、獸醫、行爲、生理、植物及歷史等各方面之研究者共同組成，進行各項與復育有關之研究工作。
2. 復育諮詢委員會：由上述各研究者及其他從事與復育研究工作相關的專家或學者組成，提供研究成果或專業知識指導復育工作的方針及解決工作進行所遭遇的困難。
3. 行政及管理：由中華民國自然生態保育協會、內政部營建署國家公園組、及墾丁國家公園管理處保育課及工務課有關工作人員等分別負責行政協調、研究支援、現場管理及復育設施建設等工作。

三、工作規畫及方式

梅花鹿復育小組將復育過程規畫爲三個階段，依序爲準備期、放養期及追蹤期，隨著各期之推展，人爲飼養管理之程度將逐漸降低，鹿隻生存之空間將逐漸擴展，且由人工圈養逐漸走向自然野放，依此逐步訓練鹿隻回復野外自立生活的能力。茲將各分期構想介紹如下：

1. 準備期：

本期工作包括梅花鹿基本資料之收集與復育實地之準備工作，因以往本種的基本資料極爲缺乏，故此方面資料之收集爲準備期之工作

重點之一。主要工作內容包括鹿隻行爲、生態、年齡及品系鑑定、鹿隻與植物之關係、基礎生理、疾病保健、養殖現況及歷史研究等項目；其次復育核心鹿群之遴選、復育地點之勘定以及規畫與建設，亦爲本期之工作重點。

2.放養期

本期之工作重點乃在於鹿隻選入復育環境後，訓練及協助其逐步回復野性，並對其適應性進行各類相關評估及研究。鹿隻遷入現場後，初期仍以人工方式圈養，此後則逐漸減低飼養管理之程度，並日漸擴大其生活空間，在詳細的計畫與觀察評估下，以分段漸進方式達成鹿隻完全野性生活之目的。本期工作內容針對遷入復育現場之核心鹿群繼續追蹤，進行各項適應性試驗及相關之後續研究，並對野放區域內之植被及生存環境作適當之管理研究，以漸次實現鹿隻行野性生活自給自足之目標。

3.追蹤期

最終階段之目標在於將已完全野性化之鹿隻釋放於其原來可能生活之環境，因此本期之工作重點在於選擇社頂復育區以外的適宜地點來釋放回復野性之梅花鹿，並對釋放鹿群繼續加以追蹤，記錄研究其野放情況，並對其與新環境間之互動關係進行探討，以建立野放鹿隻經營管理之法則。

四、執行概況

台灣梅花鹿復育研究計畫爲一長期綜合性計畫，自民國73年開始正式執行，目前已完成準備期之工作，包括基本資料之收集，復育核心鹿群之選取及遷移，復育環境之勘定規畫及現場主要工程設施之建立等；民國77年進入放養期之工作階段，對鹿隻遷入復育環境後之適應性進行各項相關研究及評估。

基本資料之收集包括鹿隻行爲、生態、生理、遺傳學、年齡鑑定、飼育保健、養殖現況、天然生育地植群分析及梅花鹿與台灣歷史淵

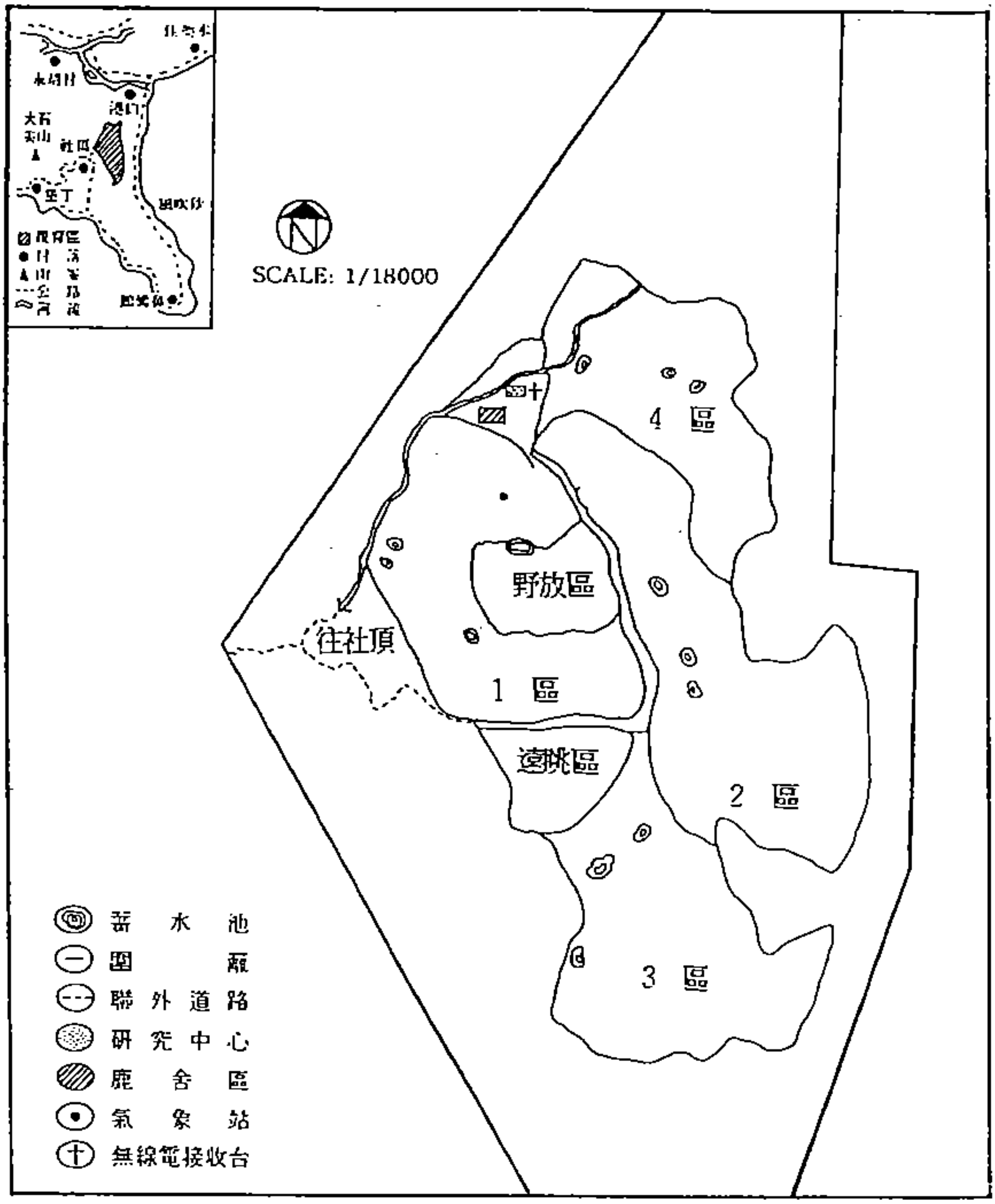
源等各項研究。在復育地點之勘選規畫方面，對數個地點審愼考慮後，擇定社頂公園北側之沿海丘陵地帶爲復育地點，於75年間完成復育區之分區設施規畫及部份之工程設計，同時發包施工，至今（80）年除少部份圍籬工作外，已完成其他各項工程設施，包括鹿舍、試驗場、研究站、試放區及各野放區之圍籬（圖 一）。

關於核心鹿群之選取及遷移，乃依據復育小組成員對台北市立動物園梅花鹿群進行兩年行爲觀察之結果，根據鹿隻個體繁殖狀況及社會地位，從其中挑選較理想之性別與年齡配比的22頭梅花鹿（5雄，17雌），於75年11月9日遷入社頂臨時鹿舍中；77年4月14日將鹿群31隻（8雄，23雌）正式遷入復育作業區；78年1月9日將鹿群中6隻個體(1雄，1雌，4幼）釋放於野放區之植生試驗區內；80年 1月23日將作業區内核心鹿群51隻中之29隻（10雄，16雌，3幼 ）正式釋放於野放區内（圖 二）。

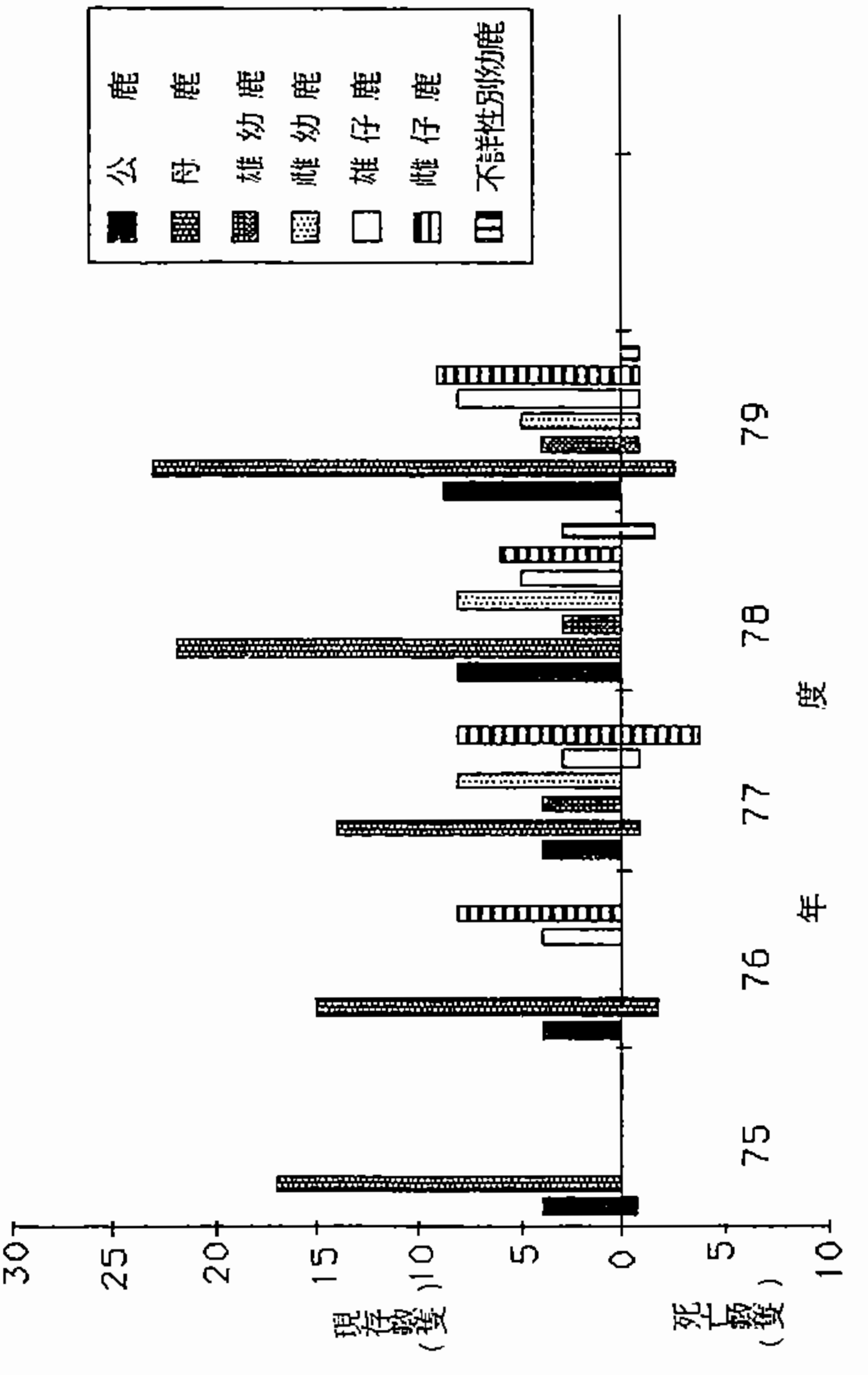
目前進行第七年度之復育工作，爲放養期之關鍵階段，部份鹿隻已遷入野放區，並逐漸停止人工飼養的工作，以瞭解梅花鹿野性回復的程度；同時以無線電追蹤，記錄野放鹿群在新環境中對空間及植物之利用，及個體間互動之關係，並設置樣區以探討不同族群密度對生育地環境的影響。

五、台灣梅花鹿之生活習性

由近年來梅花鹿復育研究小組在動物園及社頂復育區觀察圈養及半野放鹿隻的結果，或可提供梅花鹿在自然環境生活的情形。就其行爲而言，在圈養的環境下，雄鹿有佔領勢力圈的現象（王，1985；王及詹，1987），在生殖期間，雄鹿與在其範圍内的多隻雌鹿交配，顯示台灣梅花鹿與其他梅花鹿相似，可能屬於一夫多妻的社會系統；其繁殖亦有明顯的季節性，在台北動物園以10至 3月爲主（王，1985）；鹿場之養殖資料則爲 9至12月（施等，1985）；在社頂復育區則爲11至 2月。母鹿分娩時間亦因地而異，然皆發生於 6至11月間（王，1985；楊及施，1989），由母鹿分娩的資料顯示，其生殖爲每年一胎



圖一　社頂梅花鹿復育區之設施及各分區之相關位置


公 鹿
母 鹿
雄 幼 鹿
雌 幼 鹿
雄 仔 鹿
雌 仔 鹿
不詳性別幼鹿
現存數(隻)
死亡數(隻)
30
25
20
15
10
5
0
5
10
75
76
77
78
79
年 度

圖二 核心鹿群數量變化

，雌鹿在一到二歲齡間即達性成熟。

其活動模式據觀察動物園鹿隻的結果顯示爲晨昏性活動，在鹿隻遷到社頂復育區後，由實地觀察及無線電追蹤的結果，其活動亦多呈晨昏性型態，由研究者在野放區觀察到鹿隻活動時的個體數、相關位置及移動的方式顯示，台灣梅花鹿有以母鹿、幼鹿及仔鹿等爲中心成群活動的現象，此種型態與其他梅花鹿之社會系統相似。

六、目前遭遇的問題

根據學者對族群遺傳特性的估算，一個復育族群至少需有五十隻來自不同族群、具有不同遺傳特性的個體 (Frankel & Soule, 1981)，其族群繁衍及遺傳特性的保存才有較大的希望。而吾人復育研究的核心鹿群爲來自圓山之22頭梅花鹿，其早期譜系關係並不清楚，由於其圈養在一起，由吾人早期對動物園鹿群之觀察，曾有極少數公鹿稱霸，獨享與全園母鹿交配的權利，是以核心鹿群彼此間應有相當的親緣關係存在。目前核心鹿群已在社頂生活五年並繁殖兩代，至今尚未見到子代中有因近親交配所產生之遺傳上的變異現象，然此並不能保證未來族群無此現象發生。是以，如何增加現有族群遺傳的變異性亦爲當前不可忽視的工作。要達成此一目標，目前可行的方法有二：一爲與國外飼有純種台灣梅花鹿的機構交換個體或遺傳物質；二爲利用台灣現有民間飼養的梅花鹿來增加鹿群的遺傳變異性。就前者而言，目前所知飼有純種梅花鹿的有美國紐約布朗（Bronx ）動物園及英國倫敦近郊之Whipsnade Park，如有必要，或可與該處交換種源。就後者而言，台灣目前民間鹿場飼有數萬頭的梅花鹿，其中大部份皆可能爲純種，若能找出有效鑑定純種個體的方法，則可選擇個體來增加復育族群的種源。有鑑於此，復育小組曾就核型與血清蛋白等（宋等，1985；黄等，1987）特徵試圖分辨亞種特性，目前並委請美國柏克萊大學 Chuck Cook君利用最新生化技術如mitochondria DNA sequence等方法，嘗試來分辨本亞種與日本梅花鹿的差異。

七、未來展望

1.對野放區之選擇

當梅花鹿族群在復育區內達到當地所能承載之負荷量時，即是野放期的開始。野放的原則即是要選擇具有其原生存之植生環境（蘇，1985），同時亦要兼顧是否能提供應有的保護及適當的經營管理，為符合此二原則，初期野放先以社頂地區以外之墾丁國家公園內其他地區為目標，釋放後加以追蹤，使吾人確知這些鹿隻在真正大型獨立的生態體系中，無任何人為阻隔（如圍籬）的情況下能自由繁殖生活。在達此目標之後，長程目標則選擇墾丁以外的國家公園、自然保護區以及開發壓力較小、具有適合其生存環境之偏遠地區野放，希望這些地區能成為鹿群在全省各處的復育基地，以確保將來梅花鹿能在全台灣永續生存。

2.保育觀念之建立

梅花鹿復育計畫目的之一，即希望藉鹿與人溝通，使民眾能瞭解保育的真諦，故在復育小組成立之初及規畫工作時，就將社頂自然公園與復育區相鄰的一塊約六公頃的地作為鹿群遠眺區，民眾能在此區遠眺鹿群，透過公園當局設立之解說牌的解說，達到寓教於樂的目的，也可藉此活動讓民眾體會到人與動物和諧生活之可貴。

此外，為進一步讓大眾瞭解人與鹿的關係，未來墾丁國家公園將設立鹿隻展示館，其內容包括鹿隻與先民的文化淵源及經濟效益，傳統的醫藥特質，鹿隻習性的介紹及各項保育的成果。希望透過此一展示，能更進一步加強人與鹿的溝通，以達到保育的實質效果。

3.對鹿隻之經營管理

復育之最終目標即在於保護及利用梅花鹿資源，當梅花鹿數目超過當地環境之承載量時，若未對其族群加以控制，則對環境可能造成破壞。例如綠島鄉公所二年前曾將飼養之梅花鹿釋放於全島，結果鹿群對當地作物造成嚴重破壞，以致鄉公所不得不將鹿隻捕回重新圈養

。其他鹿群因數量過多，破壞植生或農作物的例子亦時有可聞。所以族群控制乃爲未來經營管理不可或缺的手段。而控制族群最重要的方法之一，即是狩獵。此法不但可有效控制族群，且可帶給參與者相當的經濟及遊憩價值。在中國傳統及世界各國當今的潮流中，鹿亦皆屬可供狩獵的品種。故吾人或可選取鹿隻野放的周邊地區，或國家公園保護區的外圍地區，設立狩獵區，定期狩獵。藉保護區族群與狩獵區族群之交流，以達到生態平衡的目的。

八、結　語

1.梅花鹿復育計畫就梅花鹿而言，繁殖並非困難之事，但要回復其對原來野外生活環境之適應，則需花費更多的心力。

2.目前世界各地爲增加經濟利益，品種改良與品系污染的現象層出不窮。要如何保存此特有亞種的固有品系及現有的遺傳特性，則是一嚴肅而困難的問題。

3.復育計畫現在在野外之繁殖幾乎已到成功的階段，將來只要數量多即可進行野放。眞正值得注意的是，一般民衆如何調適鹿隻出現在新環境中造成的影響；換言之該如何來培養民衆健全的保育觀念，則是未來面臨的難題。

4.復育計畫即是希望藉"鹿"來通往保育之路，爲達到此一資源永續的利用，在族群因保護而增加後，狩獵不僅是一項傳統，也是一合理解決資源利用的方式。

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A REVIEW OF THE RECENT RESEARCH ON *MACACA CYCLOPIS*

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Abstract. The first detailed description of the *Macaca cyclopis* was reported by British naturalist R. Swinhoe (1862). Since then, other naturalists and biologists, most of whom were Japanese scholars, had studied and published many papers on the morphology, anatomy, physiology, diseases, ecology and behavior of this species. It was not until late 1960's that local scientists began to study this endemic species, the only non-human primate native to Taiwan. Today, hundreds of Formosan macaques are still used locally for medical and other laboratory research each year; in natural or semi-natural environment, studies of their ecology and behavior, particularly their social behavior, food habits, activity and population ecology are carried out as well.

台灣獼猴的研究現況

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中文摘要

有關台灣獼猴較詳實的描述與介紹始於英人史溫候氏(Swinhoe，1862)，其後以日人爲主之研究人員曾對台灣獼猴之形態、解剖、生理、疾病、生態及行爲等方面進行研究，並發表多篇論文。但直至1960年代後期開始，我國的研究人員才逐漸開始進行台灣獼猴之研究。至今除每年仍有數百隻台灣獼猴被用做實驗動物進行醫藥方面之研究外，尚有針對自然或半自然狀態下，台灣獼猴之社會行爲、族群動態、食性與活動等行爲與生態方面之研究，正在進行中。

一・前　言

有關台灣獼猴較詳細之描述，始自Robert Swinhoe（1862）。其後以日籍專家爲主的研究人員繼續針對台灣獼猴之形態、解剖、生理、疾病及生態與行爲進行研究，並陸續發表數百篇之論文（吳與林，1986a）。台灣光復之後，台灣野生動物之研究曾停頓了一段相當長的時間。1960年代起台大醫學院彭明聰教授等陸續發表數篇關於台灣獼猴之生殖週期方面的研究（彭與賴，1968；Peng et al.，1973a，1973b）；中原大學楊錫林教授等亦先後研究以CPZ重鎮定劑、電擊及嗎啡等處理台灣獼猴，對其社會行爲之影響（楊與徐，1977；1979；楊，1983）。其間尚有McCullough（1974）、Poirier and Davidson（1979）及我國之研究人員針對台灣獼猴的分布與數量進行一般研究。1980年以來，國內對野生動物之研究日益受到重視，而台灣獼猴因其分類上之特有地位、學術研究之價值及受棲地減少及獵捕雙重壓力而數量減少之危急性，亦成爲極待研究之本土野生動物之一。本文之主要目的在介紹1985年以來台灣地區台灣獼猴之研究狀況。1985年前台灣獼猴之研究，請參考吳與林（1986b)。本文並將整理現今台灣獼猴行爲與生態方面之研究結果，尤其將著重於台灣獼猴之分布、食性、生殖狀況方面研究結果之比較。其他如台灣獼猴族群大小與組成之比較，將由本次研討會之另一演講人Dr. Norikoshi 介紹，不在此重複。

二・台灣獼猴之研究現況

1985年以來台灣獼猴之研究可略分爲野外研究、圈養研究與醫學實驗三方面。其中野外研究方面，台大動物系陸續在墾丁（吳與林，1986a；1990）、玉山（林等，1989b）、太魯閣（林與盧，1989；1990）及宜蘭仁澤進行台灣獼猴野外活動、食性及行爲等之研究。其中台大動物系博士班吳海音同學自1985年起在墾丁所研究之猴群，已在數年之間成長並逐漸分成二群（吳與林，1990）。成功大學亦在高雄壽山地區進行台灣獼猴族群分布及棲地分析之研究。此外，台大動

物系亦曾在1986～1987年間對全島台灣獼猴之分布、數量、捕獵狀況等進行調查（李與林，1987）。而許多野生動物研究人員在全島各地進行一般調查時，亦會收集台灣獼猴之資料（林，1983；林等1989a）。在圈養研究方面，台大動物系與台北市立木柵動物園，曾針對戶外圈養狀況下之台灣獼猴，進行其理毛（陳與陳，1988）、敵對（紀，1989）、生殖行爲及親子行爲（鄭，1989）之觀察研究。動物園並著手進行園內台灣獼猴血統書與基本資料檔案的建立，以追蹤其生長與生殖狀況。竹南養豬科學研究所近來也開始研究台灣獼猴等動物在不同空間大小的圈養狀況下的行爲反應，以了解飼養這些動物所需要的合理空間。至於在醫學實驗方面，據國科會依申請計畫之估計，本（1990～1991）年度台灣獼猴被用做醫學研究者約55隻。但依各大學醫學院所提供之資料，則有高達一年 170隻之使用量，進行實驗的單位包括台大、陽明、榮總、成大、高醫、長庚等，中原大學亦飼有數隻台灣獼猴。這些獼猴主要用在心肺移植、眼科、牙科、骨科及一些藥物測試之研究。由於台灣獼猴之飼養照顧需相當多的空間、食物及人力，因此除飼養獼猴外，這些研究單位亦有向民間收購動物供實驗用。

除我國之研究外，日本靈長類研究人員及日本獼猴研究小組的人員曾在1967～1988年先後來台灣多次，調查台灣獼猴的分布與現況（Masui et al.，1986；Tanaka，1986），並在東部山區，尤其是台東知本及宜蘭仁澤地區進行長期的觀察（Kawamura et al.，1988）。此外，並對以往引入日本的台灣獼猴，進行室內及野外的研究，其中野外的部分曾針對伊豆大島野放之台灣獼猴進行追蹤觀察。

三・台灣獼猴之垂直分布

根據鹿野忠雄（1929）、Kuroda（1940）及Kano（1940）之調查資料，台灣獼猴之垂直分布自平地起，其上限約在3300公尺。李與林（1987）之全島調查，所記錄到之猴群分布約在 100～3000公尺以上，亦在同樣的範圍內。而McCullough（1974）曾在3400公尺發現獼猴之排遺，而林等（1989a）在雪山調查時記錄在 3600公尺發現台灣獼

猴。因此台灣獼猴垂直分布之上限較以往所知更高。林（1985）認爲台灣獼猴之垂直分布下限已自以往之平地升至海拔1000公尺。然而李與林（1987）之調查，在海拔 500公尺以下之地區仍發現相當多群之獼猴。基本上台灣獼猴垂直分布範圍很廣，足見其適應各海拔棲地環境之能力。

Kuroda（1940）認爲高海拔之台灣獼猴在冬季會有往較低海拔遷移之狀況，此一現象在其後之調查與研究中，均未被再確認。林等（1989b）在玉山楠梓仙溪林道之調查（海拔1730～2670公尺）·雖曾記錄在8、10、4月發現獼猴之次數較少，林道沿線之獼猴排遺亦較少，但未能追蹤猴群移至何處活動；同時，月份也分散在夏、秋、春季，故此一垂直移動之說法，有待進一步之查證。

四·台灣獼猴之水平分布

Masui et al.（1986）在整理日本靈長類研究人員多次來台訪查台灣獼猴之分布資料後，報導在台灣的台北、宜蘭、花蓮、台東、台中、南投、彰化、高雄、屏東等 9縣有發現台灣獼猴之記錄。李與林（1987）之調查則顯示，台灣地區除澎湖、雲林二縣尚未有台灣獼猴之活動記錄外，其他14縣均有台灣獼猴之記錄。而二項調查之共同結論是台灣獼猴現有分布，仍以中央山脈及海岸山脈較多，亦即東部與南部數量較多。

五·台灣獼猴之食性

根據歷年來有關台灣獼猴之食性記錄（吳與林，1986；林等，1989b ；Poirier and Davidson，1979；盧與林，1989，1990；蘇秀慧，未發表報告），台灣獼猴以植物爲主食，但亦會取食動物性食物。台灣獼猴所食用之植物種類至少有３４科７９種（表一），主要食用這些植物之果食、種子、葉、嫩芽、嫩莖、樹皮等。台灣獼猴食用之動物性食物至少包括鞘翅目之甲蟲；直翅目之蚱蜢、蝗蟲；膜翅目之螞蟻；鱗翅目之幼蟲、蟲癭及甲殼類與軟體動物。根據蘇秀慧（未發表報告）檢視仁澤地區7～9月台灣獼猴之糞便，發現每月份所收集

到的糞便中，有90%～100% 之糞便內有動物性食物之殘屑，雖然動物性食物在每個糞便中所佔之比例並不高。

此外根據相關的報告，在墾丁及宜蘭仁澤地區，台灣獼猴以植物之果實爲主食，植物的葉與莖所佔食物的比例較低（吳與林，1986；蘇秀慧，未發表報告）。但玉山楠梓仙溪林道及中橫公路沿線之調查（林等，1989b ；盧與林，1989；1990）則顯示此二地區之獼猴食用葉子的比例較食用果食的比例高。而由表一亦可看出不同地區記錄到台灣獼猴所食用之差異很大。因此目前有關台灣獼猴之食性結果受限於調查時間、調查地區、調查方式及調查者所能辨識食物種類之能力等因素影響很大，台灣獼猴所利用之動、植物種類應當更多。

六．台灣獼猴之生殖周期

彭明聰教授等（1968；1973a；1973b）研究實驗室內台灣獼猴之生殖周期，發現除 6月份外，台灣獼猴終年可以受孕；同時根據當時獲得的資料，認爲台灣獼猴在野外的生殖高峰爲9月至次年1月。吳與林（1990）在墾丁地區長達 5年的追蹤，發現該地區台灣獼猴的交配季是11月至 1月，小猴在2月到6月出生，而以4月到6月爲小猴出生最多的時候。林與盧（1989；1990）在中橫沿線的調查則發現，在太魯閣至文山間，屬中橫公路海拔較低的地區（低於 580公尺），台灣獼猴之交配季主要在10月至11月，小猴在4月到5月間出生；而文山至大禹嶺段（海拔 580至2550公尺），海拔變化較大的區域內記錄到小猴出生的月份爲3月至8月，其中仍以4月至6月爲高峰，如以懷孕期爲5個半月回推，交配季爲10月至 3月，變化範圍較墾丁及太魯閣至文山段之結果爲大。而鄭任南（1989）在台北木柵動物園所做之觀察，發現在5、10、11、1月均有母猴發情交配，10、12、3、4、5、6月均有小猴出生，但仍以4月至6月爲小猴出生之旺季。探討動物園內台灣獼猴交配季提早之原因，可能是因爲所觀察的猴群在 3月中才被釋入圈養地，這些來自個別飼養環境的猴子，在經過激烈的互動關係後建立起位階的秩序，然後可能因爲社會關係的建立及個體相互之影響，使母猴很快進入發情期與新的猴王交配，而提早了生殖的過程。因此台

灣獼猴的生殖高峰大抵仍是在10月至 1月，小猴出生的高峰時間亦以4月到6月為主。然而環境、海拔分布以及猴群之社會結構與個體互動之關係均會影響其生殖的時機。

此外，吳與林（1990）在墾丁地區所研究的一個猴群在該區成立國家公園，獵捕壓力減輕之後，於 5年內生下22隻小猴，且小猴存活率為80%以上，該群在數目由10餘隻增加到20餘隻後分群。因此，在捕獵干擾少的理想棲息環境下，台灣獼猴的生殖潛力相當高。

七・獵捕壓力

根據師大山產店調查（王，1986），台灣獼猴因外型似人，一般人多不喜食用，但是每年仍有大量的台灣獼猴陸續被獵捕，主要之利用方式包括作為寵物或供醫學研究用，以及利用猴骨為中藥等用途。Peng et al.等（1973）之報告，估計過去每年約有960隻台灣獼猴被獵，其中 300隻供本地醫學用，其餘則外銷到日本等地進行醫學研究。Poirier and Davidson（1979）則估計每年有1000～2000隻的台灣獼猴被捕捉。王（1986）之山產店調查顯示，實際調查到全省山產店出售台灣獼猴的數量一年約有1234隻；而依據此一數字估計，台灣獼猴在各地山產店之總交易量每年約有3564.6隻。此外，根據李與林（1987）之全省調查，53.8% 的調查地點，均有台灣獼猴被獵捕的情形。可見台灣獼猴被獵捕的情形仍然極為嚴重。

八・保育現況

目前台灣獼猴保育所面對最大的挑戰，來自獵捕、棲地破壞、外來種所可能造成之影響以及台灣獼猴為害農作物造成農民的損失。如同前一節所述，目前台灣獼猴被獵捕的情形仍極為普遍。而在人口繼續增加與政府繼續開發的政策下，台灣獼猴的棲息地會繼續減少。此二因素都會直接影響台灣獼猴之數量。其中獵捕一項，由於近來有相當多的民眾，因曾經飼養野生動物，而了解飼養野生動物之不易與困擾，再配合更多的保育教育，可能使購買台灣獼猴做為寵物之情形減少，而逐漸減少獵捕台灣獼猴的一個誘因。至於利用台灣獼猴從事研

究及做爲藥用，則有待政府相關機構正視，並予以妥善處理。棲地的破壞，關係到許多野生動物的生存，如何保護更多的野生動物棲地，避免因不當之開發所造成之影響，亦是一項重要的課題。

國人飼養寵物的風氣，已擴及國外之野生動物，尤其是各類靈長類動物之幼體如人猿、長臂猿、懶猴、馬來猴等。目前在台灣各地，已多次發現東南亞地區之獼猴屬動物，如馬來猴在野外活動的蹤跡。而這些動物多是走私帶入的，未經正常之檢疫管道。因此不僅可能因帶疫病或因防衛之本能而攻擊民眾，對人畜健康生命造成傷害外，亦可能和台灣獼猴產生競爭。甚至如果同爲獼猴屬的動物生殖隔離不完全，而產生雜交時，更可能會造成品種的混雜與變質，甚至影響原種之適應性與活存，而逐漸使台灣獼猴走向絕種，影響甚巨。

此外，李與林（1987）的調查中，在35.1% 的調查地區已有台灣獼猴爲害果園、竹林及其他農作物之記錄。農民爲了避免農作物之損失，亦會以獸夾、陷阱、套圈、毒餌或獵槍等工具或方式，除去爲害之動物，在台灣獼猴棲地減少，而人們不斷向其棲地深入開墾的情況下，此種情形可能會有增多的趨勢，亦值得加以重視及預防。

九．總　結

自1985年至今（1991），有關台灣獼猴之研究已有相當多的進展，對於台灣獼猴的基本生物學亦有更進一步之了解。然而，由以上之回顧，亦可看出有關台灣獼猴在不同海拔、緯度、棲地或其他環境因子下之長期研究與比較仍不夠多，對於其保育及長期存續所面臨之問題，尚無妥善之解決之道，因此仍有賴更多研究人員之參與台灣獼猴之研究工作，共同努力。

表一　台灣獼猴所食用之植物種類目錄

植物種類	墾丁	玉山	中橫	宜蘭	P&D
殼斗科（FAGACEAE）					
Alnus formosana 台灣赤楊（台灣榿木）		v	v		
Castanopsis longinux 錐果櫟					v
Cyclobalanopsis glauca 青剛櫟（鐵椆）			v		
C. pachyloma 金斗椆	v				
Lithocarpus amygdalifolius 杏葉石櫟					v
Pasania formosana 台灣柯（紅校欑）	v				
Quercus morii 槲櫟（柞櫟）					v
榆科（ULMACEAE）					
Celtis sineusis 朴樹			v		
Trema orientalis 山黃麻			v		v
Ulmus parvifolia 榔榆（紅雞油）		v			
桑科（MORACEAE）					
Broussonetia papyrifera 構樹（楮樹）			v	v	
Ficus ampelas 菲律賓榕	v				
F. aurantiaca 小葉藤榕（大果榕）	v				
F. benjamina 白榕	v				
F. caulocarpa 大葉赤榕			v		
F. erecta 牛乳榕			v		
F. gibbosa 澀葉榕	v				
F. microcarpa 榕樹			v		
F. pumila 薜荔			v		

註：編號見本表末參考資料出處

F. septica 稜果榕（常綠榕）	V				
F. wightiana 雀榕（赤榕）	V				
Morus australis 小葉桑		V			
蕁麻科（URTICACEAE）					
Boehmeria densiflora 密花苧麻			V		
Debregeasia edulis 水麻		V			
Laportea pterostigma 咬人狗	V				
山龍眼科（PROTEACEAE）					
Helicia formosana 山龍眼					V
樟科（LAURACEAE）					
Cinnamomum camphora 栳樟			V		
C. insularimontanum 山肉桂			V		
Persea japonica 大葉楠			V	V	
獼猴桃科（ASTINIDIACEAE）					
Actinidia chinensis 台灣羊桃					V
薔薇科（ROSACEA）					
Eriobotrya deflexa 山枇杷（台灣枇杷）			V		
Malus fovmosana 台灣蘋果（澀梨，山仙楂）					V
Rubus pinfaennsis 鬼懸鉤子（紅毛懸鉤子）		V			
R. fraxinifolius 榿葉懸鉤子				V	
豆科（LEGUMINOSAE）					
Canavalia lineata 肥豬豆	V				
Leucaena glanca 銀合歡（白相思子）	V				
Pueraria montana 山葛（台灣葛）	V		V		
大戟科（EUPHORBIACEAE）					
Aleurites moluccana 石栗	V				
Antidesma pentandrum 枯里珍	V				

Bischofia javanica 重陽木（茄冬）	v		
Breynia accrescens 小紅仔珠	v		
Macaranga tanarius 血桐		v	
Mallotus japonicus 野桐		v	
芸香科（RUTACEAE）			
Clausena excavata 過山香	v		
楝科（MELIACEAE）			
Aglaia formosana 紅柴	v		
Melia azenarach 苦楝	v		
漆樹科（ANACARDIACEAE）			
Semecarpus gigantifolia 台東漆樹	v		
Rhus semialata 羅氏鹽膚木（山鹽青）			v
無患子科（SAPINDACEAE）			
Koelreuteria formosana 台灣欒樹（苦苓舅）	v		
Nephelium lappaceum 毛龍眼（韶子）			v
清風藤科（SABIACEAE）			
Meliosma rhoifolia 山豬肉		v	
田麻科（TILIACEAE）			
Slonea dasycarpa 猴歡喜			v
梧桐科（STEOCULIACEAE）			
Heritiera littoralis 銀葉樹	v		
胡頹子科（EOAEAGNACEAE）			
Elaeagnus sp. 胡頹子屬		v	
大風子科（FLACOOURIACEAE）			
Idesid polycarpa 山桐子		v	
千屈菜科（LYTHRACEAE）			
Lagerstroemia subcostata 九芎	v		

Passiflora edulis 百香果					V
P. suberosa 三角葉西番蓮	V				
五加科 (ARALIACEAE)					
Aralia bipinnata 裡白蔥木		V			
Scandent schefflera 鵝掌櫱	V				
杜鵑花科 (ERICACEAE)					
Gaultheria bornensis 玉山白珠樹					V
山欖科 (SAPOTACEAE)					
Palaquium formosanum 台灣膠木	V				
Pouteria obovata 山欖 (樹青)	V				
柿樹科 (EBENACEAE)					
Diospyros discolor 毛柿	V				
D. maritima 黃心柿	V				
D. sasaki 紅花柿					V
灰木科 (SYMPLOCACEAE)					
Symplocos cochinchinensis 小西氏灰木			V		
木犀科 (OLEACEAE)					
Fraxinus insularis 台灣梣				V	
夾竹桃科 (APOCUNACEAE)					
Anodendron affine 大錦蘭				V	
Ecdysanthera rosea 酸藤				V	
馬鞭草科 (VERBENACEAE)					
Callicarpa formosana 杜虹花	V				
桔梗科 (CAMPANULACEAE)					
Pratia nummularia 普剌特草					V
菊科 (COMPOSITAE)					
Farfugium japonicum 台灣山菊		V			

禾本科（GRAMINEAE）				
Miscanthus floridulus 五節芒			v	
M. sinensis 芒				v
M. transmorrisonensis 高山芒		v		
Yushania niitakayamensis 玉山箭竹		v		
棕櫚科（PALMAE）				
Phoenix hanceana 台灣海棗	v			
芭蕉科（MUSACEAE）				
Musa formosana 台灣巴蕉（山芎蕉）			v	

註：1.吳與林（1986）及吳海音（私人資料）

2.林等（1989b）

3.林與盧（1989；1990）

4.蘇秀慧（未發表報告）

5.Poirier and Davidson（1979）

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MANAGEMENT OF THE FORMOSAN REEVES' MUNTJAC (*Muntiacus reevesi micrurus*)

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Abstract. The Formosan Reeves' muntjac (*Muntiacus reevesi micrurus*) has traditionally been hunted by the aborigines for meat, but hunting pressure has increased dramatically during the past ten years, mainly to satisfy the market demand from the Chinese inhabitants of Taiwan. The market is chiefly for its meat, but high-quality leather products are also made from its hide. It is estimated that the trade value of muntjac comprises almost half of the total value of Taiwan's large market in wild game. As a result, the number of muntjac in the wild is declining.

Recent surveys showed that muntjac are still distributed widely from low to high elevations in Taiwan, and therefore the protection afforded them under the newly enacted Wildlife Conservation Law of June 1989 should allow the population to recover, given the fecundity of the muntjac, within a short period of time. In the long term, management should exploit the productivity of the muntjac and their cash-earning value to the aborigines so that hunting is eventually permitted on a sustained yield basis.

A conservation strategy is offered in this paper which would set up a management program with substantial aboriginal participation. It is argued that allowing aboriginal areas more legal control over their harvest would not only provide increased revenues for these typically poorer communities, but also give hunters a strong incentive to conserve the muntjac. It is hoped that legalization of hunting the more abundant game species, thus providing hunters with a steady source of income, would eliminate hunting pressure on Taiwan's more endangered wildlife.

台灣山羌(Muntiacus reevesi micrurus)的經營與管理

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中 文 摘 要

台灣山羌（Muntiacus reevesi micrurus）在傳統上一直是本省原住民的狩獵的對象，唯近十多年來，因為漢人市場需求大量的增加，其被獵捕的壓力，也急劇的增加。雖然台灣山羌主要是供應以肉類消費為主的山產市場，但其他的副產品（如：高品質的皮革）也同樣具有市場價值。根據估計，台灣山羌的交易幾乎佔目前全台灣山產交易總額的二分之一，使得本種的野外數量，近年來有明顯減少的趨勢。

最近的野外調查結果顯示，台灣山羌仍然普遍的分布於全省，且繁殖力相當旺盛。因此，在新實施的「野生動物保育法」的保護下，其野外族群應可在短期內有所恢復。但本種長程的經營管理策略，似應該以在可忍受的範圍內，規劃適量的收穫，以發揮本種高生殖率的特性，並可為原住民帶來相當的收入。

在本報告中，作者提出了一個以原住民參與為原則的經營管理策略，這個策略強調，若原住民對如何收穫台灣山羌有相當的自主權，則不但能夠幫助他們的經濟，也可加強原住民獵人維繫本種野外族群的意願，也希望因此提供了原住民一項穩定的狩獵收入，進而減少他們去獵捕數量不充裕、來源不穩定的其他瀕危物種。

一、前　言

台灣山羌（Muntiacus reevesi micrurus）又名台灣（小）鹿，是台灣的特有亞種之一。一般相信，台灣山羌是在上一次冰河期撤退後（約一萬年前；王鑫，1987），才因爲陸連的消失而與其祖先一分佈於中國大陸南方的黃麂（或稱中國麂，M. r. reevesi）一隔離的。現生的台灣山羌，除了體型明顯的較黃麂小、耳背的顏色也不同（台灣山羌呈紅色，而黃麂爲黃色）（Groves and Grubb，1987）以外，四肢在比例上也可能比較長（N. Chapman，私人聯絡）。

過去，本種由於數量多、分佈廣，一直都是本省原住民傳統的狩獵對象之一，與野豬和飛鼠同爲主要的食物動物（王等，1989）。許多的原住民獵人現在仍有保存山羌下顎骨的習俗（McCullough，1974；石，1989；個人觀察）。而往往經過數年的累積，一個獵人甚至能有數百個山羌的下顎骨。這些下顎骨的收集，除了有展示成績的目的外，每隔數年，獵人會將這些下顎骨，"葬" 在本族祭拜神祉之處（個人訪查）。由此可見山羌在台灣原住民的生活中，所受到的重視，因爲根據對早期狩獵／蒐集團體（Hunting-gathering Group）的研究，這種 '善待' 被獵獲個體的儀式或風俗，至少具有：(1) 安撫被獵殺、被食用的動物的靈魂，和 (2)希望這些被 "安撫" 的靈魂，回到靈魂界後爲這位獵人 "說好話" ，等兩種作用。此類儀式或風俗，源自於對超自然力（即靈魂）的畏懼，而其最終之目的則希望避免被該動物報復、保祐往後狩獵的成功、以及期望資源的不絕（R. Taber，未發表文稿）。尤其是重要的資源動物，此類儀式更是必需。也正是這種對超自然力的畏懼，節制了狩獵的數量，因爲浪費也會褻瀆靈魂和神明。

近十多年來，主要受到平地市場需求大量增加的影響，台灣山羌被獵捕的壓力，也急劇的增加。王穎等（王，1986，1988；王及林，1987）在連續三年對全省的山產店進行調查後，發現山羌的估計年銷售量，在1985和1987兩年均爲所有野生哺乳類之冠，1986年則爲第三位，僅次於野豬和飛鼠。而市場的需求程度，也使得山羌成爲原住民

獵人，最喜愛獵捕的動物之一（王，1988；王等，1989）。據估計，在1985年7月到1986年6月的一年之間，全省消費之台灣山羌，可能就超過了2萬隻（王，1986）。

同時，連續數年訪查的結果均顯示，在各類野生動物中，獵人對獵捕台灣山羌的喜好位序，遠大於他們對其野外數量的評估位序（王，1988），這也反映出，目前的獵捕量可能已超過了台灣山羌族群的"可忍受收獲量（Sustained Yield)"。因此，雖然現在大多數的原住民獵人，仍然保持其每年或每數年，輪流在不同的獵區狩獵的習慣，但獵捕壓力的快速增加，加上長久以來，自然棲息環境持續的受到人類活動的干擾，使得台灣山羌在全島的數量上，出現了相當程度的減少，且在甫通過的『野生動物保育法』中，被歸類爲"保育類"動物。

本文將整理目前我們對此種類動物的瞭解，分別就其經濟價值及市場，和其在台灣的分佈及繁殖現況做一概述，並提出一個針對台灣山羌的經營管理策略，以供參考。

二、經濟價值及市場

就經濟層面而言，台灣山羌無疑的是一種極具經濟價值的野生動物。如前所述，羌肉是本省原住民重要的食物，且很受平地消費者的歡迎，除此之外，牠的毛皮可以製成品質極佳的皮革，羌頭可做標本，而羌角也是很好的印材。同時，羌血酒也有不錯的市場（王，1988）。

根據1987－1988年度市場調查的結果，台灣山羌屠體價格爲每台斤360元左右（王，1988)。這個價錢雖然較同一資料所載的穿山甲（1031元／斤），白鼻心（825元／斤），和熊（600元／斤）的單價要少，但山羌銷售的數量遠超過這三種動物，使得山羌的買賣幾乎佔了台灣全省所有野生動物總銷售額的一半（王，1989）。因此，山羌的獵捕及出售在一般原住民獵人的收入中，佔有相當的比例（王，1989；個人觀察），也就不足爲奇了。

三、分　佈

台灣山羌是台灣本土三種鹿科動物中，分佈最廣的一種。1930年代前後，日人鹿野忠雄、堀川安市等調查的結果顯示，本種在全島（包括綠島）均可見；垂直分佈則由海平面到海拔三千公尺左右的高山，但以海拔五百到兩千公尺（堀川安市，1932）或一千到兩千公尺（鹿野忠雄，1929）的闊葉林較多。

雖然在過去的數十年間，人類的活動影響了山羌的棲息環境和數量，但由許多近年來的調查報告來看（顏，1979；林及顏，1982；王及王，1988；王等，1989；等），牠們的分佈情形並沒有很大的改變。和其它的哺乳動物一樣，台灣山羌受影響較爲明顯的，仍爲生存在低海拔地區的族群（王及王，1988）。例如，墾丁國家公園內，臨海的社頂地區，曾經也有山羌的蹤跡，但目前已不可見了（張文慶，私人聯絡）。同時，在相對的數量上，台灣的北部也較南部爲多，可能是因爲南部山羌的獵場，開發得較北部早的緣故（王及王，1988）。

另外，在顏（1979）和王及林（1987）的全省山地部落訪查的研究中，研究者均曾要求各地區的原住民獵人，對其傳統獵場中，或其居住村落所在的山區中，野生台灣山羌的族群做概略的評估。將這兩項研究所得結果做比較，則顯示台灣山羌分佈不均勻的程度，在近年來有漸增的趨勢（裴家騏，未發表資料）。這可能也是因爲在不同的地區，獵捕程度或獵捕年代的早晚，有所不同所造成的。

四、繁　殖

在野生動物經營管理上，動物繁殖的模式與特質，是在擬定策略時，所不可或缺的參考資料之一，因爲其直接影響到動物族群的生殖力。就台灣山羌而言，其生殖生物學的基本資料，以往較爲零星，且各個資料之間的差異頗大。例如：台灣山羌產仔的季節就有，在每年的二月和三月（Kano，1930；林，1983），四月到六月（林，1982），六月到九月（陳，1984），和全年（王，1986）等不同的說法。

爲了釐清這類的差異，及對台灣山羌的繁殖有較深入的了解，本文作者曾於1988年11月至1989年 2月之間，在宜蘭縣對野生的台灣山羌進行研究（Pei，1990）。在該研究期間，作者檢視了屍體及活體總共 439隻的雌、雄台灣山羌。所有樣本均來自宜蘭縣大同鄉的舊金洋山區。以下，即爲該項研究部份結果的摘要。

1.雌性的生殖：

根據所得卵巢和其它雌性生殖道的解剖，並輔以個體第二性徵發育程度和年齡的資料，雌性山羌的生殖具有以下幾點特徵：(1)約5個月大或更早時就開始排卵，排卵的間隔約14天（Chapman & Dansie，1979；Chaplin & Danngerfield，1974），但最初的第1、2次的排卵可能無法受孕；(2)在性成熟之後，終生排卵，且有生育力。兩邊卵巢的功能並無差異，每次排卵之排卵數可能不止一個；(3)雌羌具有產後發情之特徵，在產後極短的時間內即可再受孕，並不受哺乳影響。(4)懷胎數每胎以1仔爲原則，同時胚胎的著床明顯的集中在右子宮角內；(5)成年母羌（＞2歲）的受孕率接近百分之百。

另外，在國外對黃麂的觀察曾報導，雌羌在生產後的第18個小時（Dansie，1970）和第三到第四天之間（Soper，1969），就再度進入發情期；而在此次台灣山羌的樣本中，也發現一隻懷孕約 1個月的雌羌剛將一個卵排出卵巢。這些資料顯示，山羌很可能不但有產後發情的現象，而且在懷孕期間仍然有卵子的成熟，甚至排卵。

產後發情，或甚至在懷孕期間卵巢仍持續生產成熟的卵子，使得雌羌無論是分娩或流產，都可以立即再懷孕，因而大大的提高了雌羌的繁殖力。

2.雄性的生殖：

由睪丸的切片得知，雄山羌在 7－11月齡時達到性成熟，開始製造精子。每年的4、5月是成年雄羌的落角期，而每年的8到9月則爲蛻絨期。但與溫帶地區的鹿種不同的是，山羌在角週期中的任何階段（亦即全年），睪丸內均可發現成熟的精子，而溫帶地區的鹿種在絨角階段是不製造精子且無生殖能力的。這項結果，再加上本文作者（19

88－1989）在動物園內的觀察，顯示雄羌全年都具備生殖能力。

3.生殖的季節：

由在兩個月的研究期間，就觀察到不同月份出生的幼羌的事實來看，台灣山羌全年均可繁殖，並無明顯的生殖季節。但根據幼獸（＜2歲)出生月份的分佈來看，在1988年的6到8月間，研究族群有一個明顯的生殖高峰，而在1987年的 3到 5月間及1987年的11月到1988年的 1月之間又各出現兩個較不顯著的生殖高峰。由於這些生殖高峰之間的間隔（分別爲7和8個月）與山羌的懷孕期（約 7個月；Barrette，1977）相吻合，此族群很可能正在重覆一個週期小於12個月的生殖週期，而本區季節性的狩獵活動可能是造成這個現象的原因。

4.成長：

雖然台灣山羌不論雌、雄均在不滿 1歲即可繁殖，但體格的長成則較晚。雄山羌停止體格生長的年齡在 2至 3歲之間，而雌山羌則在 2歲左右停止生長。成年雄羌的體重（ 8.3公斤）明顯的高於成年雌羌的體重（ 6.8公斤）。這種體重上而非骨骼上的變性型（ Sexual Dimorphism），很可能是反映了雄羌的社會地位高於雌羌的。若不考慮體型的大小，台灣山羌成長所花的時間，較其它的鹿科動物長了許多。例如：成年體型比台灣山羌大30倍的麋鹿（Moose，*Alces alces*），長成所需的時間就與台灣山羌相仿（Verme，1970）。

如此緩慢的幼年成長速率，每胎產 1仔，再加上比較長的懷孕期（Dansie，1970），較短的餵乳期（僅 7到 8週；Barrette，1975；Yahner，1978），以及生產相對體型過大的仔羌（Dansie，1983）等特徵，都顯示山羌不但是一個典型的出生時個體成熟度就很高的物種（即所謂 Precocial species），且其程度也大於其它的鹿科動物。而在哺乳動物中，出生時個體成熟度高的種類，往往其親代對子代的撫養和照顧，在產後的投資要小於產前（Case，1978；Martin，1984；Martin & MacLarnon，1985）。也就是說，成年山羌在幼羌出生後，除了餵乳期間之外，所扮演的角色並不重要。

5.圈養繁殖的現況：

市場的鼓勵，使得近十多年來，許多人開始嘗試台灣山羌的圈養和繁殖。雖然圈養下的繁殖並不困難，要達到大量生產以滿足市場的需求，卻不容易。這可能是因爲在自然狀態下，山羌是獨居生活（Barrette，1977；Yahner，1980），或形成 2－4隻的小團體（Dansie，1981；Morris，1986)，所以在密度過高的圈養環境下，繁殖力和幼羌存活率都受到影響的結果。因此到目前爲止，山產市場中，圈養繁殖的台灣山羌所佔比例，仍然是微不足道的（個人觀察）。也因此更加重了野生族群的負擔。

五、經營管理之策略

綜合而言，台灣山羌在山產市場的佔有率極高。雖然在過去的數十年間，受到山產市場擴大的影響，野外的數量有持續下降的趨勢，但地理上的分佈卻沒有明顯的改變，顯示適合其生活的環境仍多存在，或是其對環境的適應力頗強，而數量的降低應該主要是獵捕壓力的升高所致。因此，加強宣導以減少民眾的消費，和加強取締獵捕、販賣以杜絕市場，應可在短期內抒解台灣山羌的獵捕壓力，使其得以減緩數量下降的速度，甚或明顯地恢復其野外的族群。

但是，台灣山羌同時也是一個繁殖力很高的動物，這也可說明爲什麼，在經過了這麼多年的超量獵捕後，牠們在野外仍能有相當的數量。本文作者曾勘查過一個休獵約一年的獵場，在適合山羌活動的地形上，獸徑、獸跡就清楚可見，其中還有一塊約10公尺平方，被踩踏得相當光秃的林地，四周有許多的獸徑會聚於此（當地原住民稱其爲"山羌的運動場"）。據當地的原住民說，一個獵場若休獵3－4年，其內的植被就會遭到極大的破壞。山羌族群的恢復力由此可見一斑。所以，長遠來看，並考慮台灣山羌所可以帶給原住民的經濟利益，似乎仍應如過去一些學者的建議：在可忍受的範圍內，規劃適量的收穫（Manage for sustained yield)(McCullough，1974；顏，1979；王，1986；等）。

以下則爲作者試擬的一個台灣山羌經營管理的架構，由於並未經過實際的試驗和評估，在此僅能就其原則做一說明：

1.以現有且生產力高的原住民傳統獵區爲經營的單位（獵場）。目前全省約可規劃出10到20個具如此條件的經營單位，而這些也正是目前供應消費市場的主要地區。同時，座落在這些獵場周圍的原住民村落，大多也仍有相當比例的業餘或職業獵人。他們對山區的瞭解和熟悉，將有助於對現場的管理（見後段）。狩獵活動只能在規劃的獵場中進行。

2.由獵場周圍的村落，在地方權責單位的協助下，組成該獵場的管理單位（如：管理委員會），負責協調各村落、分配獵捕數量以及因狩獵活動而得來之利益、管理和維護獵場....等事宜。

3.將狩獵執照分成"職業狩獵（Commercial Hunting）執照"和"運動狩獵（Sport Hunting）或娛樂狩獵（Recreational Hunting）執照"兩種。其中職業性狩獵在狩獵方法上的限制較少，允許在短期內有相當的收獲量（例如可用陷阱捕捉），且其獵物可以買賣；而運動性狩獵則必須採用限定的獵具，且獵物不可買賣。兩種狩獵活動均要受狩獵地區、狩獵對象和數量之限制。由於目前的職業獵人中，以原住民佔大多數（王，1986），且考慮獵人對獵場照顧的義務，"職業狩獵執照"的申請應以原住民爲對象。

4.每年某一獵場所可獵取的山羌總量，由地方權責單位定訂之。而該獵場的管理委員會，則依據此數量，自行擬定職業狩獵和運動狩獵之比例。例如：某獵場某年的可忍受獵捕量爲 1,000隻，經當地原住民村落協調後決定，其中的 700隻由該地區，持有"職業狩獵執照"的獵人去收穫（並可限制獵季的長短）；另外的 300隻則開放，由向政府申請"運動狩獵執照"的人來獵捕。區內非職業獵人的住民，或職業獵人比例低的村落，則可由這些運動性獵人的光臨而獲益。例如：以台灣山區地形的岐嶇和險峻而言，絕大多數對山地不熟悉的外來獵人，就需要僱請當地的嚮導，以降低危險，和提高狩獵活動的品質。除了擔任嚮導以外，外來的運動性獵人，在當地的民生消費、夜宿....等，也都可以爲當地的居民帶來收入。但獵區管理委員會向進入該管獵區的運動性狩獵者，收取門票或類似的管理費，則並不恰當，因爲大多數的山地都是歸政府而非原住民所有的。

5.由於台灣山羌全年都在繁殖，不需要對狩獵的季節做特別的限制。唯考慮原住民的農耕季節和被獵物在山區的保存（王，1986），職業狩獵仍以在冬季進行爲宜。另外，雖然成羌被獵取後，對其已斷乳的幼羌存活的影響，可能不大；但以何種陷阱或如何設置陷阱，方能避免捕到哺乳中的雌羌，仍待進一步的研究。

如此的策略，除了希望能有效的控制山羌的獵捕量外，也有以下的幾個目標：

1.將狩獵區的管理工作交由當地住民執行，減少政府人員的負擔；

2.增加原住民的收入，加強年輕的原住民對其村落的向心力；

3.鼓勵原住民維持其生活環境的自然風貌；

4.因爲對獵捕的動物可以嚴格的要求，應可明顯的減少職業獵人非法獵捕極需保護之動物的情形和動機；

5.各地區可以以呈現其文化特色的方式，來吸引更多的外地獵人，因而鼓勵了原住民保存其民族文化。

六、結　語

Dr. Graeme Caughley 在其所著的 "Analysis of Vertebrate Populations" 中曾指出，野生動物的經營和管理應該包含保育(Conservation)、可忍受量的收穫（Sustained Yield Harvesting）和控制（Control)等三個主要的範疇，至於該採何種策略，則需視當時的族群狀況及變動的趨勢而定（Caughley，1977）。而一個經營管理策略的成效，首先取決於該策略是否能執行。

就目前來看，國人對野生動物的消費習慣、平地與山地生活條件的差距、執法人力的不足....等，都是施行 "野生動物保育法" 的障礙。作者在本文中所建議之台灣山羌的經營管理策略，就是希望能夠排除這些障礙，以期達到 "維繫自然生態的平衡" 和 "維繫自然資源的永續使用" 之保育目標。

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BIOLOGY AND CONSERVATION OF THE PANGOLINS

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Abstract. This paper reviews the taxonomy, distribution, general morphology, behavior and ecology, of the world pangolins. This paper also describes that the strong hunting pressures have made Cape pangolin an endangered species and some other pangolin species rare animals. In order to preserve the pangolins from extinction, it is urgent to protect their habitats as well as enforce the law against poaching.

Key words: Pangolin, *Manis*, biology, conservation.

穿山甲的生物學及其保育

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摘　　要

本報告綜論穿山甲的分類、分佈、一般形態、行為及生態。本報告也說明了強大的獵捕壓力，使得南非穿山甲瀕臨滅絕、其他數種穿山甲淪為稀有。為使穿山甲免於滅絕，嚴格取締違法狩獵並保障其棲息地，實已刻不容緩。

關鍵詞：穿山甲，生物學，保育。

穿山甲屬於哺乳動物的鱗甲目(Pholidota)，鱗鯉科(Manidae)。穿山甲古名鯪鯉，《本草綱目》(李時珍，明朝)記載，「其形肖鯉，穴陵而居，故曰鯪鯉，而俗稱穿山甲」。Sowerby(1925)說福建人稱穿山甲為 La-li，(即〝鯪鯉〞)，這和臺灣人對穿山甲的稱法相同。

知道穿山甲是什麼動物的人並不多，對牠了解的人更少，很多販賣野生動物的商人把穿山甲當成爬蟲類(趙榮台，1989)。穿山甲的英文是 pangolin，英語系國家也鮮有人知 pangolin 這個字，有人甚至說 pangolin 這個字聽起來像是一種樂器(Coulson，1985)。其實 pangolin 這個字係源自馬來語，表示〝蜷曲〞(to roll up)的意思(Cansdale，1947)，因為穿山甲在遇警時，有立刻綣曲成球的習性。

一般而言，過去的學者均同意全世界有 7 種形態差異明顯的穿山甲；其中4種穿山甲分佈在非洲大陸，3種分佈在亞洲。不過，這7種穿山甲倒底應該歸於幾屬(genera)，一直沒有定論。Pocock(1924)仔細地比較了現生穿山甲的外部形態，回顧檢討前人對現生穿山甲的分類及命名，並據以做下了現生穿山甲應分為 6 屬 7 種的結論(表1)，然而 Pocock(1924)將 7 種穿山甲分為6 屬的極端分類在 Simpson(1945，p.195)看來既不必要，又不方便。而 Emry(1970，p.461)認為把現生穿山甲分為 6 屬固然過於極端，如果將7種均歸於一屬(即 Manis)也不恰當。因此他建議採取中庸之道，應該把亞洲的 3 種穿山甲和非洲的 4 種穿山甲分為不同的屬，而非洲的 4 種穿山甲可以再進一步分為兩個亞屬(subgenera)，甚至兩屬。根據晚近的分類，Nowak and Paradiso(1983)把現生穿山甲分成了 1 屬、5 亞屬、7 種(表1)。

中國穿山甲依其地理分佈又進而被分為臺灣穿山甲 Manis pentadactyla pentadactyla、華南穿山甲 M. pentadactyla dalmani、海南穿山甲 M. pentadactyla pusilla (Allen, 1938；中文名參考賴景陽，1986)。臺灣穿山甲(Manis pentadactyla pentadactyla)是臺灣的特有亞種。臺灣穿山甲目前尚分佈於中央山系的周邊地區，

表 1 · 現生穿山甲種的學名、中文名及其分佈

Pocock (1924) 之命名	Nowak and Paradiso(1983)	中文名[*]	分佈
Manis pentadactyla	Manis manis pentadactyla	中國穿山甲	尼泊爾、錫金、緬甸、泰國北部、中南半島、中國南部、臺灣、海南。
Phatages crassicaudata	M. m. crassicaudata	印度穿山甲	印度半島、錫蘭。
Paramanis javanica	M. paramanis javanica	爪哇穿山甲	緬甸、泰國、中南半島、馬來半島、蘇門答臘、爪哇、婆羅州、巴拉望和周圍島嶼。
Smutsia temminckii	M. smutsia temmincki	南非穿山甲	查德和蘇丹至西南非和南非。
Smutsia gigantea	M. smutsia gigantea	大穿山甲	塞內加爾至烏干達和安哥拉。
Phataginus tricuspis	M. phataginus tricuspis	白腹穿山甲	塞內加爾至肯亞西部、南至尚比亞、或莫三鼻克北部。
Uromanis longicaudata	M. uromanis tetradactyla	長尾穿山甲	塞內加爾至烏干達和安哥拉。

[*] 參考賴景陽 (1986)。

全島所有的山麓丘陵及台地、海岸山脈、大屯火山區、臺北盆地、埔里盆地以及屏東沖積平原。500m 上下爲臺灣穿山甲最常出現的海拔高度，而 2,000m 左右應是臺灣穿山甲的垂直分佈上限（趙榮台，1989）。

與其他哺乳動物相較，穿山甲的形態相當特殊。Blandford（1888-1891）詳盡地描述了穿山甲的形態特徵：

> "頭小而狹長，前尖後寬，嘴甚小，眼小。耳殼小或退化。頭部上方、體軀背部、側部、整個尾部、四肢外側覆有屋瓦排列般的甲片。頭部和體軀下方、頭的側方、四肢的內側沒有鱗片，但覆有一些毛。甲片與甲片間有一些剛毛。所有的趾上都有微彎的爪，前足的爪比後足的爪長，第 3 爪是最長的爪。..... 頭骨形狀奇特，後部圓形，向前逐漸縮小，使頭骨略呈圓錐狀。頭骨平滑沒有隆起。顴弧（zygomatic arch）不完全，沒有顴骨（malar bone）。眼窩（orbit）和耳門骨凹穴（temporal fossae）無法區分，顎骨（palate）狹長，偏向後方。..... 沒有鎖骨（clavicles），爪的指骨末端雙裂。具有兩個乳頭。"

穿山甲在過去以其無齒及解剖形態等性狀被列爲貧齒目（Edentata），而據今日的瞭解，上述特徵不過是趨同適應（convergence）的現象，穿山甲在現生哺乳類中還找不到近親（參見 Emry, 1970；Lekagul and McNeely, 1988）。

穿山甲以白蟻和螞蟻爲食（徐龍輝等，1983；楚南，1912，1923；堀川，1922；Bequaert，1922；Büttikofer，1890；Kreyenberg，1907；Pagēs，1975，1976；Schultze，1914；詳見 Redford，1987）。穿山甲也可能吃食土中的甲蟲、蟑螂、蟾蜍、胡蜂及其他昆蟲的幼蟲、蚯蚓等（徐龍輝等，1983；趙榮台，1989; Sowerby, 1925）。除此之外，穿山甲在進食時，也一併吞下沙粒、石頭，甚至小草、樹枝（Coulson，1989）。

穿山甲具有許多形態和行爲的適應（adaptation），以便取食螞蟻和白蟻：(1) 穿山甲強壯的前肢可以輕易打開蟻窩（Bequaert，1922）；(2) 穿山甲的長爪便於用來挖掘洞穴和蟻窩；(3) 穿山甲的舌肌經過胸部，著在骨盤（pelvis）之上。成體舌長可達 20～30cm（徐輝龍等，1983；Cansdale，1947；Jerdon，1874）。穿山甲的舌呈蠕蟲狀，舌向端部逐漸扁平。由於繁多的下頷腺（submaxillary gland)分泌充足的唾液，使得舌頭經常保持黏性(Blandford，1888-1891)。當穿山甲以前足的爪破開螞蟻或白蟻窩時，舌就快速地舔食螞蟻的成蟲、幼蟲和卵，連同雜七雜八的小碎片一齊吞下肚去（Cansdale，1947)。穿山甲取食螞蟻或白蟻時，舌頭每分鐘來回伸縮可達 80 次以上(楚南，1923)。(4)此外，當穿山甲以前爪剝開蟻窩時，可能遭遇成百上千的螞蟻，穿山甲的皮膚、可以關閉的鼻孔和耳以及厚眼瞼都可以保護自己不被螞蟻攻擊（Nowak and Paradiso, 1983)。爬到甲片上的螞蟻可以抖掉。另有記錄穿山甲甚至會到蟻窩邊，豎起甲片，讓螞蟻爬滿身，然後蓋起甲片，跳到水裡，再豎起甲片，讓螞蟻浮在水面上，以便取食（李時珍，明朝；堀川，1922；Nowak and Paradiso, 1983)；(5) 穿山甲的胃也因取食螞蟻而適應（adapt）成奇怪的形態：胃壁有厚肌肉，尤其是靠近幽門的部分（Blandford，1888-1891)。由於穿山甲沒有牙齒，胃壁披著角質膜，藉吞進胃中的小砂石，起磨碎食物的〝咀嚼〞作用。胃壁黏膜特化成一層角質的上皮（horny epithelium)，在靠近食道的賁門區（cardiac region）形成皺摺，這裡的皺摺比胃部其餘地方的皺摺更密集（程紅等，1986)。在幽門區（pyloric part）胃小彎的末端，中央膨大形成一個研磨器官（organ of trituration)，或稱幽門球（pyloric globe)(程紅等，1986）其上覆有無數的角質齒，並可由其下強而有力的肌肉牽動。胃腺（gastric glands）形成一些大容量的腺體（glandular bodies)，這些腺體把大量的分泌經由腺管（glandular ducts）注入胃中。穿山甲取食的時候把整隻的昆蟲連同唾液、沙粒，甚至於大小如豆的小石頭都一齊吞下。這些混合物經由胃的蠕動加以攪拌，而胃的內壁則由角質的上皮保護不致受傷。大量的胃液

傾入胃中的混合物，然後在幽門區的研磨器官進行最後的碾磨（參見程紅等，1986；Bequaert, 1922；Weber，1904)。

穿山甲棲息在亞熱帶和熱帶地區的森林或草原裡，牠們喜歡土壤潮濕、腐植層厚，適於白蟻和螞蟻繁殖的地方（房利祥及王少龍，1980)。穿山甲多爲夜間活動，只有非洲的長尾穿山甲爲晝行性（Cansdale，1947)。牠們的視覺很差，嗅覺卻很好（Schultze，1914)。穿山甲嗅葉特別發達（陳淑姿等，1990)，顯見主要依靠氣味做爲溝通。全世界 7 種穿山甲身上都具有肛門腺（anal gland)，肛門腺的分泌物可以貯存在肛門囊（anal sac）裡，以便隨時噴出做爲防禦之用(Brown and Macdonald, 1985)。這個腺體也可能有助於個體間傳遞訊息。穿山甲的成獸會在獸徑上留下氣味做爲記號（Pages，1970)。此外，穿山甲的足底（soles）和頸側都有腺體，可能負責化學訊傳（chemical communication）的功能(Brown and Macdonald，1985)。穿山甲的聽覺退化，牠們也沒有聲音（voiceless)（Swinhoe，1870)。

穿山甲可分爲陸棲（terrestrial）和樹棲（arboreal）兩類。在非洲，數量較少的長尾穿山甲爲樹棲性，爬樹時十分敏捷（Pages，1970)，而體型最小也最常見的白腹穿山甲，雖大多在地面活動，卻也很能爬樹（Bequaert，1922；Pages，1970)。亞洲的中國穿山甲、爪哇穿山甲也以地面生活爲主，但都巧於爬樹(堀川，1922；Schultz，1914)。陸棲的種類掘穴而居。Kingdon（1971）敘述大穿山甲的洞穴有 5m 深，40m 長；臺灣穿山甲居住的洞穴有 3～5m 長（趙榮台，1989)；亞洲穿山甲的洞穴與此類似，在多石土壤中長 1.5～1.8m，在疏鬆土壤中，則可達6m，甚至更長(Lekagul and McNeely，1988)。除了人口眾多和密集耕作的地區以外，穿山甲都能居住；換言之，穿山甲的生活習性並不和人類相衝突。Pages (1970, 1975) 對三種非洲穿山甲的活動範圍（home range)、行爲、社會關係（social relationship）做了詳盡的研究，並認爲簡化的生態習性、缺少掠食者以及缺少特殊的形態和行爲（例如訊息溝通方式的減少），使得穿山

甲成爲一種社會結構簡單卻高度特化的 (highly specialized) 動物。

穿山甲爲獨棲或成對生活，或許終年均能繁殖（徐龍輝等，1983；Nowak and Paradiso，1983)，但 Cansdale (1947) 稱西非的穿山甲在 10 月的雨季繁殖。一般而言，成熟的穿山甲，每胎產一仔。南非穿山甲之妊娠期大約 139 天 (Van Ee, 1966) 。新生胎兒200～500g，出生後第二天甲片才硬化(Nowak and Paradiso，1983)。不過徐龍輝等 (1983) 則敘述海南穿山甲近一月齡時，鱗片漸次角化並變爲黑褐色。海南穿山甲雌獸育仔期又能受孕。母性強，在新一代出生後，雌獸仍不遺棄前仔獸，每每將之在同一洞中繼續哺育，掏洞時往往一起被掏獲（徐龍輝等，1983)。廣東龍門縣一獵人，曾在一洞中挖到公、母並包括兩胎幼仔在內的4 頭穿山甲，仔獸分別重1.5 公斤和 0.25 公斤，可見穿山甲一年能產兩胎（徐龍輝等，1983)。Swinhoe 在澳門 (Amoy) 曾買了一家族的中國穿山甲，這個家族包括母穿山甲、公穿山甲和三隻小穿山甲 (Swinhoe, 1870)，印證了上述的說法。據 Cansdale (1947) 的報告，幼獸一生下來就必須能夠活動，因爲母獸沒法抱牠，而幼獸也不能像蝙蝠那樣依附在母蝠的腹上。小穿山甲很自然地騎在母穿山甲的尾巴上，一直到小穿山甲離開母親爲止（房利祥及王少龍，1980；Eisenberg，1981)。小穿山甲有時用四肢緊抓著母親，有時候則用尾巴緊纏著母親。遇警時母體把幼體捲在中間 (Nowak and Paradiso，1983)。

穿山甲行動遲緩，十分膽小。一旦受到驚擾，頂多發出嘶嘶之聲 (Schultze，1914)，然後就蜷曲成球，由強而有勁的尾巴緊緊裹住身體，幾乎沒有動物可以把綣曲的穿山甲掰開來（楚南，1923；Blandford, 1888-1891)。如果硬把蜷曲的穿山甲掰開，穿山甲會從肛門附近噴出一種惡臭、辛辣的液體，這種液體會刺激黏膜 (Bequaert，1922)，使油漆變色，回復不了原色 (Bates，1905)。穿山甲的爪不是用來防禦的，不過當牠們在掙扎的時候仍不免抓傷人。至於穿山甲的寄生蟲就目前所知，包括吸蟲 (Echinostoma malayanum) (Pande，1979)、線蟲 (Trichochenia meyeri)(Cameron and Myers, 1960；

Naidu and Naidu，1981)、和蝨子 (ticks)(Cansdale, 1947；Hutton，1949；Jerdon，1874)。除了人類以外，似乎沒有什麼其他的動物捕食穿山甲。

印度穿山甲肉被（印度的）土著當做春藥（aphrodisiac）(Jerdon, 1874）。穿山甲肉味鮮美，非洲人和亞洲人都捕捉牠來食用 (Cansdale, 1947)，亞洲穿山甲的爪、甲片、毛和身體其他部分在各地常被當做高價值的避邪物 (Bequaert，1922)。臺灣穿山甲的經濟利用包括以其皮革生產皮革製品，以其鱗片（甲片）製藥或避邪、製作標本、以及提供食用。這些經濟誘因對穿山甲造成強大的獵捕壓力，其中尤以皮革加工所造成之獵捕壓力最大。估計在 1950～1970 年代僅爲供應皮革生產而獵捕之臺灣穿山甲每年高達 6 萬隻（趙榮台，1989)。Lekagul and McNeely (1977) 報告亞洲穿山甲由於甲片可製藥（外用兼內服）而受到極大之獵捕壓力。1958 至 1964 年間，沙勞越（Sarawak）合法出口的穿山甲甲片就在 60 噸以上（相當於 50,000 隻穿山甲的甲片)。又據說南非穿山甲的甲片可治性病（venereal disease)，但此說法與犀牛角可治病一樣，沒有藥理學證據 (Lekagul and McNeely, 1977)。南非穿山甲已被列爲 CITES的附錄一動物，其數量在南非似有減少的趨勢（Anonymous, 1978, in Coulson,1989)，Bothma (1975) 認爲馬拉威(Malawi) 境內的南非穿山甲已屬稀有。泰國的野生動物保護法 (Wild Animal Preservation and Protection Act B. E. 2503，1961) 將爪哇穿山甲和中國穿山甲列爲第一類被保護的動物 (Protected Wild Animals of the First Category)，允許捕捉，禁止宰殺。在臺灣，過去常見的穿山甲，如今已淪爲稀有（林良恭，1981；趙榮台，1989)。世界各地的穿山甲就像非洲的穿山甲一樣：一些國家公園雖然保護了穿山甲及其棲息地，但是違法狩獵卻對國家公園以外地區的穿山甲構成嚴重威脅 (Coulson，1989)，使得牠們的數量急遽減少。

穿山甲難以人工飼養 (Menzies，1963)，關起來的穿山甲大多拒食。穿山甲的頭部構造也使人無法強迫牠們進食。世界各地的動物園

都嘗試過人工飼養穿山甲，由於無法長期大量供應穿山甲取食所需的白蟻和螞蟻，必須使用替代食物餵養穿山甲 (Menzies, 1963, 1966)。不過到目前爲止，或許由於我們對穿山甲的營養需求不甚瞭解，飼育的穿山甲經常斃死，少有人工繁殖成功之例 (Menzies，1963，1966)。目前所以無法有效地保育穿山甲，顯然是由於我們對穿山甲生物學的知識不夠，以及難以確實執行對穿山甲的保護所致 (Coulson, 1989)。由於人工飼養穿山甲還有許多技術上的困難有待克服，要保存穿山甲，最好的辦法是保障其棲息地，而嚴格取締違法狩獵穿山甲更是使這種動物免於滅絕的不二法門。

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Trip Report, Taiwan, March 26 to April 5, 1991

Jack H. Berryman

As a guest of the Taiwan National University, I was invited to present a paper at the International Conference on Wildlife Conservation; and, as a guest of the Council of Agriculture, to stay over the following week. My wife June accompanied me.

The Conference was co-sponsored by the Taiwan National University and the Council of Agriculture and held at the Academia Sinica in Taipei.

The Academia Sinica is a research institution which provides the opportunity for research in an environment free of other responsibilities. It is funded by the Government, encourages research in all fields in a campus-like situation with facilities for research, conferences and housing for visiting scholars. Dr. Kun-hsiung Chang is head of the Sinica's Institute of Zoology.

The Conference took place March 25 to 29 with the first two days devoted to papers and discussions and the last three to a trip to the Alishan Forest Recreation Area, Yushan National Park and return.

Overall direction of the Conference was by Dr. Yao-Sung Lin of the University. Papers were presented by six Japanese, two U.S., and a number of Taiwan speakers. I conveyed the greetings from the Association's Executive Committee, presented a paper and co-chaired a panel with Dr. Ling-Ling Lee of the University. The papers ranged from scientific to management and philosophical subjects and were attended by about 280 participants. The trip included 34 speakers and others associated with the conduct of the Conference.

Alishan Forest Recreation Area

On March 27 we traveled south by bus to Alishan Forest Recreation Area and were briefed at the headquarters by Mr. Kuang-Shein Qu of the Taiwan Forestry Bureau. We were housed in cottages of the Alishan House Hotel where the Forestry Bureau hosted two splendid banquets of traditional Chinese cuisine.

The Alishan Forest is a very popular tourist area of 98,000 acres, with elevations extending to about 12,000 feet in spectacular mountain and forest scenery. We were there on the first day of a Chinese Holiday weekend and the crowds were tremendous.

The narrow, winding approach road passes through extensive moutain tea fields, up into dense tree stands. It was surprising to me to see palm, bamboo and coniferous stands in a single field of vision, passing then into predominantly coniferous stands. With elevations from almost sea level to over 12,000 feet, the forest includes all of the vegetation of the tropical, subtropical and temperate zones.

The Alishan Forest was logged over, mainly during the Japanese occupation (1895 to 1945). Some of the most impressive, and at the same time, tragic sights are the tremendous stumps of ancient redwoods which now support their own crown of flora. They are everywhere to be seen, along the trails and roads and in the openings. They are picturesque reminders of a day gone by. There is only one living ancient redwood, with a few twig-like branches struggling from a failing trunk. There are some mature redwood stands elsewhere on Taiwan. A reforestation program was begun, also during the Japanese period.

We arose before 4:00 a.m. to take a small narrow gauge train to Sunrise Mountain. Here we witnessed a dramatic sunrise at 6:15 a.m. with the sun appearing over a peak, all above a complete blanket of clouds many feet below us.

The railroad, over 70 years old, is one of the three existing high mountain railways in the world. It climbs through 50 tunnels, over 80 bridges to the high of Alishan, including three spiral circles and some "z turns." It is an adventure!

Yushan National Park

Returning to a traditional Chinese breakfast, we departed by bus for nearby Yushan National Park -- the newest of four national parks. Its centerpiece is Mount Morrison, the highest in all Eastern Asia -- over 13,000 feet. It is also known as Jade Mountain because when its peak is snow capped it appears as light jade. It is a spectacular mountain.

We toured the Park with Wildlife Biologist Robert Liutz Law who described the larger forms of wildlife which include the ferocious Formosan black bear and the macaque. We toured the new visitor center, scheduled to open on April 13. It will be a modern, state-of-the-art facility with the latest audiovisual equipment and interpretive services, all in a magnificent setting with a wonderful view of Jade Mountain.

We also visited the headquarters -- a combination office-residence, where we were hosted to a fine luncheon by Secretary Tsai By-Lu who could not be present.

We returned to Alishan Forest where we again boarded the train to view the "orchid gardens", where we visited a 50 hectare (124 acre) site, the Taiwan Pleione Nature Preserve, devoted exclusively to preservation of the Taiwan Pleione Orchid which, I believe, is a unique concept -- a preserve for a single species.

This orchid, which occurs on rock surfaces in the cloud zone, is not endangered but is extremely vulnerable because of its elevation, light, humidity and temperature requirements. Oddly enough, these requirements are best met in some of the steep cuts made for the railroad where the necessary requirements, plus the disturbance factor, are best satisfied. Access by the railroad, however, also renders the orchic more vulnerable to public abuse of several kinds. Many of the small, beautiful blossoms can be observed in a single field of vision. We were allowed off the train; tourists are not. The forestry officials are struggling to assure the success of this small plant preserve.

Enroute back to Taipei, we stopped at Taijoun and had a farewell lunch at the Beautiful Garden Restaurant -- a very splendid event, with more courses than we counted or needed. It was a fitting conclusion.

The conference was certainly a success for reasons that are difficult to summarize. There was an intellectual and factual exchange and sharing in which all participants were involved -- especially interesting, I assume, to the Taiwan attendees. The trip then provided for an informal continuation of the exchange; and, the Japanese and U.S. delegates had an opportunity to become more familiar with Taiwan's resources and their management and needs; also with resource personnel. We learned a great deal -- new experiences from daylight to bedtime each day. And, despite language barriers and cultural differences, we all got along very well indeed.

<u>Yangmingshan National Park</u>

On the morning of March 31 (Easter), Mr. Chau-Jen Chen of the Forestry Department picked us up to go to Yangmingshan National Park, about six miles north of Taipei where we were met by Chief Michael Lee and Miss Iris Lai of the Park staff. Following a briefing and slide show, Miss Lai served as guide for a tour of the facilities and as much as we could see on a rainy, windy, misty day.

Yangmingshan Park consists of 28,300 acres. As with other Taiwan parks, the land is not all federally owned. Rather, there is a mixture of city, county and private lands. The Park, however, has legal authority to control development, land use and practices within the boundaries. Land within park boundaries is classified by management areas: ecological preservation; unique landscape; recreation; general control; and archaeological where appropriate. The predominant feature is an old volcano, though fumerals and steam are still active.

For us, the most interesting part of the tour was the progress made since our 1986 visit when we travelled on dirt roads and visited a small, makeshift office. Now, on the Park's fifth anniversary, there is a staff of 125; there is a good road net, four vistior centers and three visitor servie centers. The visitor center at headquarters has an excellent and imaginative interpretation display and, among other features, the Park had a bird trail and butterfly walk. The Park had two million visitors last year and predicts three million annually by the year 2000. Its proximity to Taipei subjects it to heavy use. The progress in the development and management of the Park is remarkable.

Our visit was concluded with an excellent luncheon hosted by the Park.

Taroko National Park

On April 1 we were met by Miss Li-Hung Lin (Lily) of the Council of Agriculture and travelled south by train to Hsin-cheng, just north of Hualien where we were met by Miss Chin-Yen Hsu (Claire), thence to the Taroko National Park Headquarters, where we met Park Superintendent Dr. Kuo-Shih Hsu.

Taroko Park includes 92,000 hectares (227,240 acres), mostly undisturbed, mainly in the Central Mountain Range. It fronts on the Pacific Ocean and rises to the west to over 12,000 feet. It is bisected by the Liwu River which in earlier times carved much of a very deep and narrow gorge. The Park is home to the indigenous Taiwa people, one of the aboriginal Taiwan tribes.

The highway, immediately north of the headquarters, is cut from the sheer Ching-shui Cliff which drops abruptly to the Pacific Ocean. Here is the easternmost extension of the Asiatic Continent. Not far offshore are the deepest waters of the Pacific; and, it is in this area where the Pacific Oceanic Plate collided with the Asiatic Continental Plate, the resulting upthrust creating the island of Taiwan. The upthrust also raised the marble from the sea bottom to form the walls of the Gorge, a condition seldom found elsewhere in the world. "Spectacular" does not do credit to the formations, the mountains rising from the sea and the Gorge. To see this location is not just interesting, it is an experience.

With elevations extending from sea level to over 12,000 feet, the climatic zones extend from subtropical to subfrigid and include all of the vegetative types found on the Island.

There are 122 species of birds, 14 of which are endemic; and 24 species of large mammals, including the Formosan black bear, the Formosan sambar and the Formosan macaque.

The Park Headquarters is new and includes the latest in interpretive services, a visitor center and dormitories. The Park works to protect the culture and historical features of the Taiwan people and to include these in its educational programs.

On April 2 we toured Taroko Gorge. This Gorge, cut through the virtually solid marble by the Liwu River, winds and twists, its marble walls rising almost vertically from the bottom to over 2,000 feet. There are frequent waterfalls that cascade down the sheer cliffs.

A narrow road has been cut -- more properly chiseled -- through the gorge. There are many tunnels and a few limited "pull offs." The most spectacular is the nine-tunnel area. We were fortunate that traffic was halted to permit repair work caused by an earthquake several months ago, allowing us to leave the car and more leisurely look at the Gorge.

The original road was cut through by hand during the Japanese occupation. The road and tunnels are a monument to those who labored under such adverse conditions. Over 425 men lost their lives building the road. There is a Buddhist shrine in their honor high on the mountain near the entrance.

The Park hopes to improve sections of the road to improve access and viewing. It will be costly and difficult. I believe the Park's greatest challenge is going to be managing visitor pressure as the Park becomes more well known and more accessible to a growing outdoor-minded public. It will not be possible to handle many more passenger cars than at present. I believe it will soon be necessary to restrict the highway to public vans or shuttles. It will also be necessary to develop anti-littering measures including public education and enforcement -- here and at other parks and public recreation areas.

We returned to Taipei by train.

Our trip was concluded by a splendid farewell dinner, hosted by the Council of Agriculture and Vice Chairman Ling Shiang-nung, and attended by Council, University and sinica officials. Former Vice Chairman Chin-Chao Koh, now Chairman, Taiwan Sugar Board of Directors, was present and has lost note of his interest in resource management -- nor his good humor.

Vice Chairman Ling Shiang-nung announced plans to establish a native wildlife institute to be located in central Taiwan. The institute is authorized and funded; groundbreaking will be in early July 1991.

He also expressed strong displeasure that U.S. political leaders and the media were not recognizing the positive steps taken by Taiwan to comply with international arrangements to reduce bycatch and were, in fact, leveling unwarranted criticism.

General Comments. This extended trip provided the opportunity to update the impressions formed during our 1986 visit (Berryman report June 12, 1986); to learn of programs and problems; to see more of Taiwan; and to share views with participants in the Conference.

Again, a major impression was the number of young, well-educated, competent professionals, dedicated and eager to advance sound resource management. The leadership is progressive and the entire cadre is thirsty for new view s and knowledge. Many are scheduled for foreign assignments to learn of advancements in their fields that can be applied in Taiwan. Taiwan's new Premier has a degree in Agriculture from Cornell University.

And, there is specific progress since 1986. The broad Wildlife Law has been passed and is being implemented. One new park has been established, bringing the current number to four; a new park is being established; a preserve on one of the islands southeast of Taiwan is being planned for the benefit of wildlife and aboriginal people. The Council of Agriculture is also pioneering various uses of preserves, one being the 50 hectare orchid preserve in Alishan Forest.

The budget for wildlife has doubled in recent years and San-Wei Lee has been promoted to Deputy Director.

But, there are problems. We were advised that the population increase, sharpest in all Asia, has leveled off. Nevertheless, it was announced while we were there that Taipei was the most densely populated city in the world -- 10,160 people per square kilometer or 3,921 per square mile! Human needs for food, fiber and recreation continue to increase the pressures on resources, coupled with the need to develop and fuel Taiwan's expanding economy. The problems of pollution, erosion and sedimentation continue. It will take Herculean efforts to achieve economic growth without further environmental degradation.

We had the impression of more littering in both urban and rural situations, including parks, than in 1986. And, waste management problems have become more severe. We observed one landfill on the outskirts of Taipei that had all but eliminated a valuable wetland.

While it is not attracting attention or concern, there are the first evidences of an animal rightist or protectionist movements developing in Taiwan. I would suggest that the leadership be alert. Success in Taiwan depends upon a balanced program of sound management, including use.

Taiwan has a sound, well staffed resource management organization in place; it has a sympathetic leadership. It also has profound challenges ahead.

Again, we were impressed by the friendliness, vigor and courtesy of all people we encountered, the cooperation and courtesies extended by our hosts and the excellence of the cuisine. It was a priviledge to participate even momentarily in the evolving Taiwan wildlife experience.

The role of the International Association in supporting and assisting Taiwan is much appreciated and the relationship should be sustained.