

## COMMENTARY

# Development of behavioral studies in Chile between 1984 and 1998

## Desarrollo de los estudios conductuales en Chile entre 1984 y 1998

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### ABSTRACT

The development and the current state of behavioral studies in Chile was analyzed considering articles on Chilean fauna published between 1984 and 1998 (203 articles). The number of articles on the subject of animal behavior has increased significantly along the period studied, indicating an increasing interest on this research. However, the international impact of Chilean research has been comparatively low. Proposals to stimulate the development of this research area in Chile are: i) that main research universities in Chile recruit well-trained behavioral ecologists. This will have immediate impact by increasing the number of courses in animal behavior, which will attract a new generation of biology students into this area, promoting the persistence and growth of the Chilean Ethological Society, and stimulating research in animal behavior; and ii) that Chilean scientists working in animal behavior establish academic links with foreign colleagues specifically trained in this area.

**Key words:** animal behavior studies, Chilean fauna.

### RESUMEN

El desarrollo y estado actual de los estudios sobre conducta animal en Chile fueron analizados considerando los artículos sobre fauna de Chile publicados entre 1984 y 1998 (203 artículos). El número de artículos en conducta animal incrementó significativamente a lo largo del período estudiado, lo cual indica un interés creciente en este tipo de investigaciones. Sin embargo, el impacto internacional de la investigación chilena ha sido comparativamente bajo. Las propuestas para estimular el desarrollo de esta disciplina en Chile son: i) que las principales universidades que priorizan la investigación científica contraten a ecólogos del comportamiento bien entrenados. Esto tendrá un impacto inmediato incrementando el número de cursos en comportamiento animal, lo que atraerá a una nueva generación de biólogos hacia este campo, promoverá la persistencia y el crecimiento de la Sociedad Chilena de Etología, y estimulará la investigación en comportamiento animal; y ii) que los científicos chilenos que trabajan en comportamiento animal establezcan vínculos académicos con colegas extranjeros entrenados específicamente en esta área.

**Palabras claves:** estudios de conducta animal, fauna chilena.

### INTRODUCTION

The study of animal behavior can be broadly defined as the study of anything that an organism does involving action and response to stimulation. Tinbergen (1963), one of the founders of the study of animal behavior, proposed four main questions that could be asked about a particular behavior: What are the mechanisms that cause it? How does it develop? What is its survival value? How did it evolve? These questions can be reduced to the understanding of the proximal (immediate) and evolutionary (ultimate) causes of animal behavior. Thus, a thorough study of animal behavior needs the interaction with a vast

array of different disciplines (Krebs & Davis 1997).

The interest in the understanding of the causes of animal behavior has increased (e.g., Goodenough et al. 1993, Gross 1994), not only due to the natural desire to have a deeper understanding of animal life, but also due to the high applicability of those studies. In fact, they may help to ensure animal welfare, not just in their natural conditions but also in laboratories and zoos (Goodenough et al. 1993). In the area of animal production, there is an increased awareness of animal welfare, and "Applied Ethology" has acquired a high relevance (FEDMVZ 1995). Among others, such studies help solve problems

of animal health, since the observation of behavioral changes are important tools to detect diseases (Montero 1994). Those studies also help propose alternatives to optimize animal productivity. Animal production enterprises are beginning to understand the importance of allowing animals to develop their natural behavior in order to increase the effectiveness of animal production (Fraser & Broom 1990, Mendl et al. 1992, Cassini & Hermites 1994, FEDMVZ 1995, Sisto & Troeglen 1995). Control and management of plagues is another example in which the effective application of a control plan depends on the knowledge of the behavior of wild fauna (Galindo 1995).

Throughout the world, habitats are being lost and degraded endangering natural populations. Thus, there is a widespread concern on the effect of such changes on species diversity and abundance. Nowadays, it has become clear that the success or failure of conservation schemes may depend upon a detailed understanding of animal behavior (Sutherland 1998), and in the integration of animal behavior with other disciplines (Promislow 1996, Clemmon & Buchholz 1997, Goss-Custard & Sutherland 1997, Caro 1998).

Considering the general increasing interest in the study of animal behavior, both at the basic as well as the applied level, it is interesting and important to determine the degree of development of these studies in Chile. That need is particularly important considering the high degree of endemism as well as the comparatively poor species richness of Chilean fauna (Simonetti et al. 1995). Thus, to assess quantitatively the development and the current state of behavioral studies in Chile, articles published between 1984 and 1998 dealing with the behavior of Chilean fauna were revised. Such time window was chosen only for practical reasons, mainly since older literature is of much restricted access. Articles were retrieved from the Biosis Previews database, one of the largest available, using the following key-words: behavior, behaviour, Chile, and Chilean. In addition, all articles published by authors found in that first search, and also authors who submitted communications related to animal behavior in the meetings of the Chilean Societies of Ethology, Ecology and Biology were also revised. This search gave a total of 203 articles, which included most of the studies published between 1984 and 1998, as judged by the fact that a final search in Biosis Previews on all authors of articles selected, did not add new articles to the list (list at <http://abulafia.ciencias.uchile.cl/articulos.htm>). Results were analyzed using comparisons of proportions, Spearman rank correlations, and Kruskal-Wallis tests (Zar 1996).

### The facts

The number of articles on animal behavior on Chilean fauna has increased significantly along the period studied (Fig. 1), indicating an increasing interest in this area. The positive slope of this trend is maintained even if the values of 1985 and 1997 (with the minimal and maximal production) are removed from the analysis. In addition, the slope is greater than the overall trend for Chilean science in a comparable period of 15 years (4 vs. 2.4, for animal behavior and overall Chilean science, respectively), and much greater than that for the subset of biological sciences, with a slope close to zero (Allende & Ureta 1993). This is not surprising for a relatively young discipline in Chile such as animal behavior.

Research has not been randomly distributed across taxa. Among vertebrates, mammals and birds have been the most studied taxa (Fig. 2), while reptiles, amphibians and fishes have received much less attention (comparison of multiple proportions,  $P < 0.001$ ). There was no correlation between the number of articles (from the set of 203) in a given group and the number of

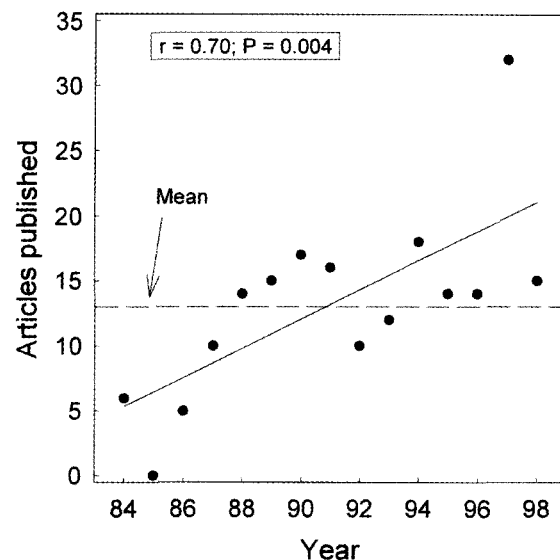


Fig. 1. Articles published each year concerning animal behavior of fauna present in Chile, between 1984 and 1998. Data were fitted to a linear model. The horizontal line represents the mean number of articles published per year. If the data for 1997 is excluded, the correlation value is  $r = 0.67$  with  $P = 0.008$ .

Artículos publicados cada año relacionados con conducta animal de la fauna presente en Chile, entre 1984 y 1998. Los datos se ajustaron a un modelo lineal. La línea horizontal representa el número promedio de artículos publicados en un año. Si se excluye el dato de 1997, el valor de la correlación es  $r = 0,67$  con  $P = 0,008$ .

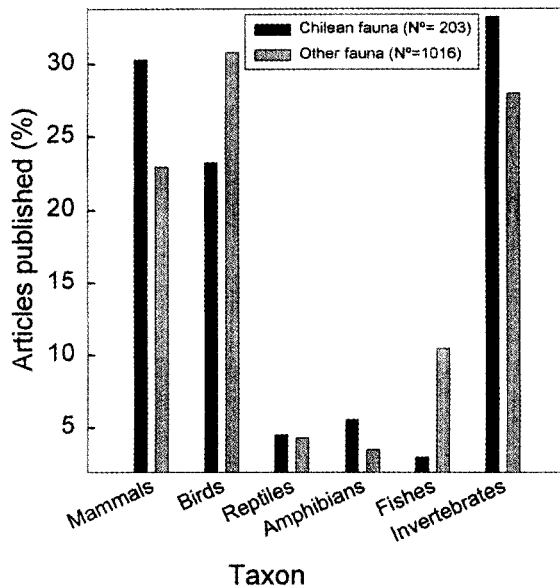


Fig. 2. Percentual distribution of publications by taxon concerning behavior of fauna present in Chile, between 1984 and 1998, and publications on behavior of other fauna in the journals *Animal Behaviour*, *Behavioral Ecology*, *Behavioral Ecology & Sociobiology* and *Ethology* between 1998 and 1999.

Distribución porcentual de artículos por taxon relacionados con conducta de la fauna presente en Chile entre 1984 y 1998, y publicaciones sobre conducta de otra fauna en las revistas *Animal Behaviour*, *Behavioral Ecology*, *Behavioral Ecology and Sociobiology* y *Ethology*, entre 1998 y 1999.

species of that group found in Chile (Spearman rank order test,  $P = 0.54$ ). Thus, the ratio between the number of articles and the number of species in the group varied from 0.004 and 0.005 for invertebrates and fishes, respectively, to 0.41 in mammals. From an analysis of 1016 papers published in the last two years in the journals *Animal Behaviour*, *Behavioral Ecology & Sociobiology*, *Behavioral Ecology*, and *Ethology*, the pattern of interest in the different taxa did not differ from the one found in Chile (comparison of proportions,  $P > 0.05$ ) (Fig. 2).

To assess the distribution of research among different areas within animal behavior, the 203 articles revised were assigned to the categories used in the 1999 version of the International Ethology Congress (Sridhara 1999) to organize meeting sessions. This may be taken as representative of international trends given the total number of participants (369) from 42 countries (Fig. 3). Not surprisingly, fewer categories were represented within studies of the Chilean fauna (21) than within 1999-IEC communications (34). This

situation prevailed when only articles published in 1997 and 1998 (more strictly comparable to the 1999-IEC) were considered. Contrarily, at the 1999-IEC the main categories were mate choice and reproduction, and communication. These differences suggest that topics in animal behavior performed with Chilean fauna are not performed according to current fashion, in contradistinction with the situation of the type of taxon studied (Fig. 2). Moreover, the analysis of the evolution of the topics of the papers presented at the biannual meetings of the Society of Behavioral Ecology during the last 30 years, indicate that the number of studies in foraging behavior has decreased, and that in sexual selection, increased (Gross 1994).

Additionally, the 203 articles were classified according to the authors' affiliation as of Chilean, foreign or mixed affiliation, i.e., collaborative work. After 1987, authors affiliated to Chilean institutions produced most of the articles, with an average of 58 % from the period 1988 - 1998 (Fig. 4), while the number of articles with foreign or mixed affiliation reached averages of 21% each. As a measure of the impact of the

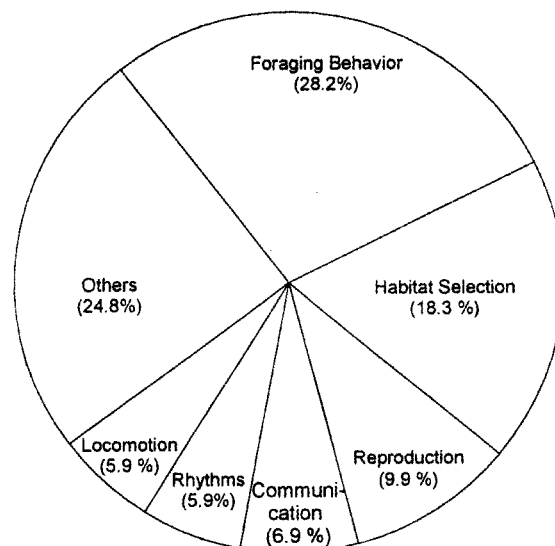


Fig. 3. Topics addressed in behavioral studies of the fauna present in Chile, and published between 1984 and 1998. The category "others" includes 15 areas such as intraspecific and interspecific interactions, behavioral endocrinology and genetics, development and behavior, and life history.

Tópicos abordados en los estudios conductuales de la fauna presente en Chile, publicados entre 1984 y 1998. La categoría "otros" incluye 15 otras áreas, entre las cuales se incluyen interacciones intra e interespecíficas, endocrinología y genética conductual, desarrollo y conducta e historia de vida.

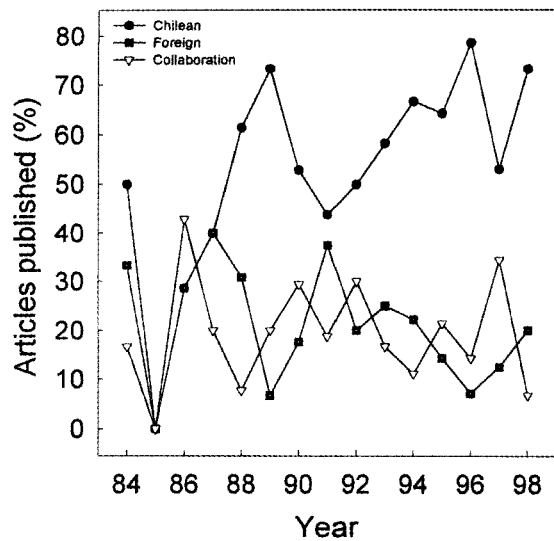


Fig. 4. Annual variation of the percentage of articles published as a function of author's affiliation.

Variación anual del porcentaje de artículos publicados en función de la afiliación de los autores.

research produced, the number of citations that each of the 203 articles received between 1985 and 1998 were retrieved from the Institute for Scientific Information (ISI) database. There were significant differences in the number of citations of articles in the three affiliation groups (Kruskal-Wallis test,  $H = 228.4$ ;  $P < 0.001$ ). Articles by authors with foreign affiliation were cited more often than those of the other groups (Fig. 5). The proportion of non-cited articles was relatively high in all cases (35, 42 and 41% for articles produced by foreign scientists, Chilean scientists, and in collaboration, respectively).

Can these differences in number of citations be explained by considering the type of journal where the different types of authors published their results? Fig. 6a shows that most research was published in foreign journals (non-Chilean journals). Chilean scientists published more articles in foreign than in Chilean journals (comparison of proportions,  $P < 0.05$ ), while foreign authors working with fauna present in Chile rarely published their studies in Chilean journals (comparison of proportions,  $P < 0.001$ ). Articles produced in collaboration were mainly published in foreign journals (comparison of proportions,  $P < 0.001$ ). However, if the journals where articles were published are divided as ISI and non-ISI, then the ratio of ISI/non-ISI publications was similar among the three author affiliation groups (comparison of proportions,  $P > 0.05$ ) (Fig. 6b). Hence, the type of journal where Chileans publish their

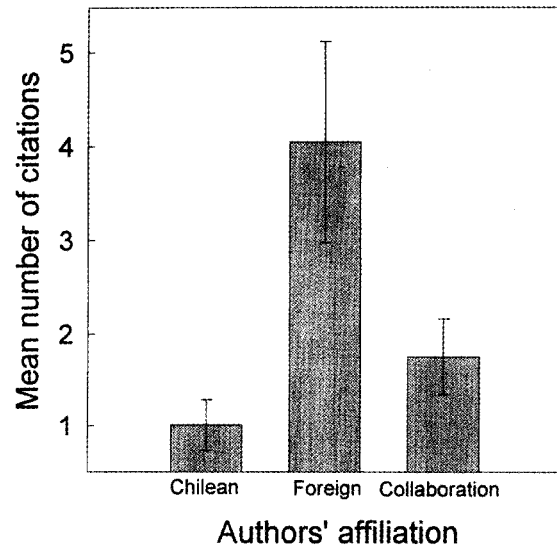


Fig. 5. Mean number of citations of the 203 articles reviewed, according to the authors' affiliation. Articles that were never cited were excluded from the analysis. Lines show standard errors.

Número promedio de citaciones que tuvieron los 203 artículos revisados, en función de la afiliación de los autores. Los artículos que nunca fueron citados, fueron excluidos del análisis. Las líneas representan errores estándar.

work is not the only source of its lower impact. We do not have a clear idea of the reason for this situation, although a plausible hypothesis is that Chileans are not working on "hot topics", and are thus less cited.

#### Facts behind the facts

Although an important number of Chilean scientists are producing articles which may be considered as studies on animal behavior, most of these scientists do not have the field of animal behavior as their main research interest. Although we have not evaluated this objectively, it seems that most naturalists such as ecologists, physiological ecologists, and zoologists have a tangential or sporadic interest in animal behavior. This is reflected in the facts that only 18 of the 203 articles were published in journals which concentrate on behavioral studies: Aggressive Behavior; Animal Behaviour; Behaviour; Behavioral Ecology & Sociobiology; Behavior Genetics; Ethology, Ecology & Evolution; Hormones & Behaviour; Journal of Comparative Physiology: A. Sensory, Neural & Behavioral Physiology, while the vast majority of articles (130) were published in journals which sec-

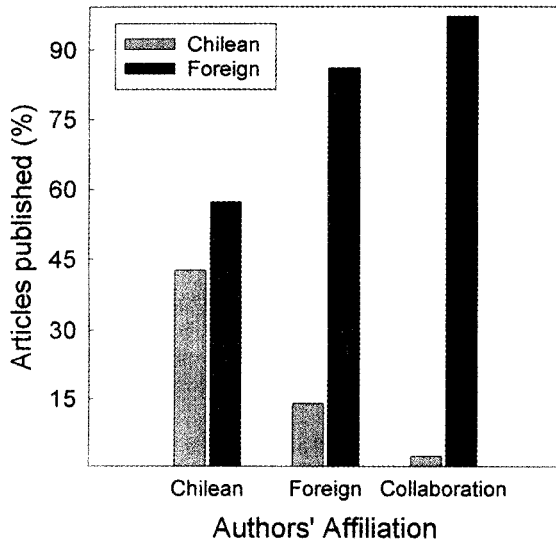


Fig. 6a. Percentage of articles published in Chilean or foreign journals, as a function of the authors' affiliation.

Porcentaje de artículos publicados en revistas chilenas o extranjeras, en función de la afiliación de los autores.

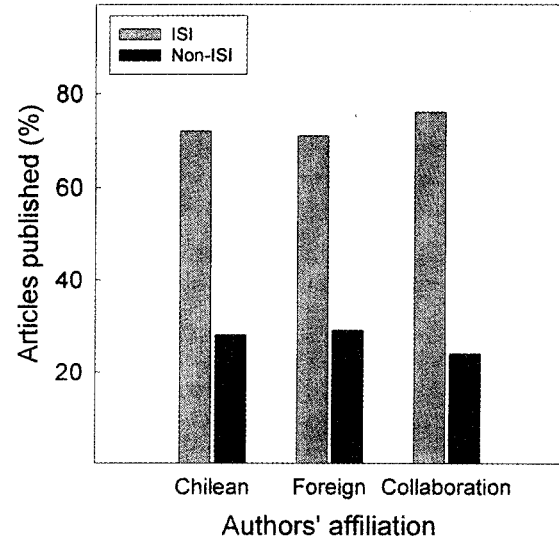


Fig. 6b. Percentage of articles published in ISI or non-ISI journals, as a function of the authors' affiliation.

Porcentaje artículos publicados en revistas ISI o no-ISI, en función de la afiliación de los autores.

ondarily include studies related to behavior (e.g., Ecology, *Oecologia*), and the remaining articles (55) in journals concerned directly with the taxon studied (e.g., *Auk*, *Journal of Mammalogy*, *Journal of Herpetology*, *Revista Chilena de Entomología*). It is noteworthy that no articles published in specialized journals such as *Behavioural Ecology*, *Journal of Experimental Analysis of Behavior*, *Animal Learning and Behavior*, and *Behavioral Processes*, were retrieved by the search performed. Furthermore, behavioral studies in Chile have not been regarded as an autonomous discipline. This is clear from the analysis by Camus (1995) of the articles published between 1983 and 1995 in *Revista Chilena de Historia Natural*, the most important journal in Chile and Latin America dealing with Natural History (Rau 1997). Articles on animal behavior were included in the area of autoecology, which is itself included within the broader domain of ecology.

The small number of scientists directly working in animal behavior in Chile has affected the teaching of this discipline in Chile. Data obtained from a study performed in 1995 on undergraduate and graduate teaching of ecology in Chile (Grez et al. 1995), indicated that of the 56 undergraduate courses in ecological areas given by 19 Universities, none dealt with animal behavior. On the other hand, only two out of 67 graduate courses in ecology offered by four universities dealt with animal behavior. Therefore, the teaching of be-

havior is rather limited, although in some cases it is included as a tangential topic in courses such as "Ecology of the individual".

#### *Toward developing studies on animal behavior in Chile: a proposal*

In spite of the comparatively small group of scientists working in animal behavior in Chile, the First Ethology Meeting was organized in 1994 by Universidad Metropolitana de Ciencias de la Educación. In 1996 the Chilean Ethological Society was formed (Beltrami 1999) and meetings began to be organized biannually. As shown in Fig. 7, the number of presentations at those meetings has experienced a tendency to increase (Beltrami 1994, Angulo 1995, Ipinza 1996, Chiappa et al. 1998). In addition, during 1998 the Chilean Ethological Society organized periodical conferences in animal behavior, aimed at undergraduate students. These activities are important because they increase the motivation to develop these studies in Chile, despite the fact that the number of scientists actively participating in the Chilean Ethological Society is small (less than 20), including academics and Ph.D. students.

The main conclusion of the present work is that the study of animal behavior in Chile needs further development, specially considering that Chilean research has a low international impact and

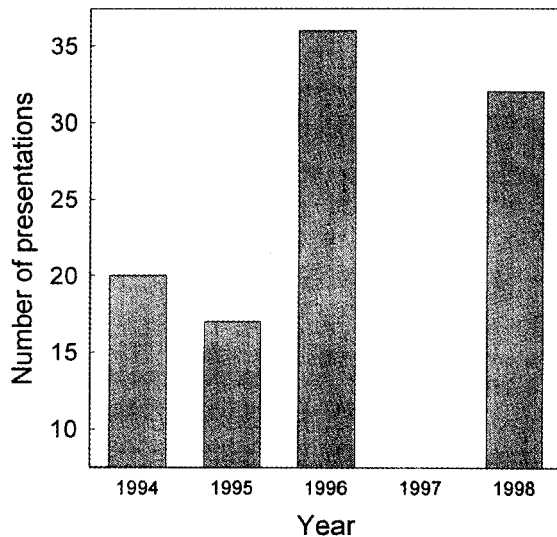


Fig. 7. Number of presentations in the Chilean Ethological Society meetings. After 1996 meetings began to be organized biannually.

Número de presentaciones en las Jornadas Chilenas de Etología. Después de 1996 las reuniones comenzaron a ser organizadas bianualmente.

that there are broad and important areas of animal behavior that have not been addressed in Chile. Hence, our main suggestion is that this discipline should be reinforced. As shown for other disciplines of science (Macilwain 1999a), conditions in Chile are suitable to produce new and relevant knowledge. Therefore, there is no reason to think that this would not be possible in the behavioral area. As stated in the introduction, studies on animal behavior can be the keystone in disciplines such as Conservation Biology. For example, Chilean lizards were exported in high numbers mainly as pets to USA and Europe during the 1980's and the beginning of the 1990's (Veloso et al. 1995). This situation, added to the fact that some species have shown changes in their natural antipredator mechanisms due to human presence (Labra & Leonard 1999), produced an important population decline in those species; hence, application of a suitable conservation program for some lizard species seems essential. On the other hand, since not only lizards but many animal species have important problems associated to their conservation (Glade 1988), the study of the behavior of Chilean native fauna is urgent, from the basic to the applied level.

How can an increased development of behavioral studies in Chile be stimulated? We believe that the recruitment of well-trained behavioral ecologists in the main research universities in Chile should have an immediate impact by in-

creasing the number of courses in animal behavior, which would attract a new generation of biology students into this area, promoting the persistence and growth of the Chilean Ethological Society, and stimulating research in animal behavior.

The latter point must be analyzed considering the overall characteristics of the Chilean scientific community. This community has recently been recognized as the most perfectly formed in Latin America, whose success has been related to two important factors: i) most established scientists were trained at the best research universities in USA or Europe; and ii) they maintain collaborations with foreign universities (MacIlwain 1999a, 1999b). In contrast, few scientists actively participating in the Ethological Society did their graduate studies abroad. Therefore, since basically there are no courses and no graduate programs in animal behavior, these scientists are mainly self-taught in terms of animal behavior, a condition that may explain some of the shortcomings of this discipline in Chile. Under this context, it seems that Chilean scientists who are working in animal behavior should establish academic links with foreign colleagues specifically trained in this area. Fortunately, Chile has developed an extensive network of cooperative programs with several countries of Europe and USA (CONICYT 1999), which should allow the development of collaborative research and graduate sandwich programs. In this way, we expect that in the near future animal behavior will grow as a more robust discipline.

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