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CONSERVATION-ORIENTED HERPETOLOGICAL RESEARCH IN ISRAEL

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Israel is small and shared by contrasting ecological regions. Local amphibian and many reptilian populations are at peril as components of endangered ecosystems, and because they live at the limit of specific ranges and requirements. Some of them are also endangered commercially. Most local herpetological research efforts have been conservation-oriented on three levels: (1) Studies of endangered species: ecology in the field, specific requirements (incubation etc.) and taxonomic definition of taxa for protection. (2) Studies of other species, contributing data to conservation policy. (3) A policy to prefer investigations not requiring the collection of specimens.

Key words: Amphibia, Reptilia, research, conservation, Israel.

INTRODUCTION

Problems of nature conservation are particularly acute in Israel because of a special combination of local circumstances:

(1) The country is situated at the boundary of the Mediterranean (*sensu stricto*) and Saharo-Arabian regions, so that it is sharply divided into mesic and desert parts (Yom-Tov and Tchernov, 1988). As a result, (1a) the flora and fauna are particularly heterogeneous, interesting, scientifically important; and (1b) ecosystems are vulnerable, as each is marginal, existing at the limit of acceptable abiotic conditions.

(2) The country is small, and rapidly being "developed" by an increasing human population (Orni and Efrat, 1980). In addition to the familiar urban, agricultural and industrial components of development, here military and security factors claim large areas. Hence (2a) quantitatively, the sizes of all free habitats are not only initially small but also rapidly and heavily encroached upon; (2b) qualitatively, the "free" areas suffer many types of pollution, ranging from the overflow of industrial and urban waste to the litter of excursionists; and (2c) many organisms are endangered, especially widely-roaming animals having access to poison coming with agriculture, which almost nowhere is far away.

Thus, in Israel the survival of practically all ecosystems depends on management (*sensu lato*), which should be based on information, which needs to be derived from research.

In many ecosystems in the world, amphibians and reptiles are a key component: burning little food to maintain a stable body temperature, and for other reasons, they turn most of what they eat into biomass. So they provide much biomass for higher predators. In many habitats, their biomass resembles that of birds and mammals (Pough, 1980). Hence, knowing the ecology of amphibians and reptiles is often vital for understanding and managing an ecosystem. Indeed in some countries much relevant research is in progress (Bradshaw, 1986; Harless and Morlock, 1979; Heatwole, 1976; Huey et al., 1983; Pianka, 1986; Seigel et al., 1987).

Israel's herpetofauna comprises at least 102 species and subspecies: 7 amphibians, 6 marine turtles, 5 land and freshwater turtles, 43 lizards and 41 snakes. Actually the frog *Discoglossus nigriventer* is almost certainly extinct (Werner, 1988). This is extraordinarily the only species which expired on a continent, among the 23 full species of amphibians and reptiles which have vanished from the world in the last 2000 years (out of 10,227 species). All others expired on (often small) islands (one, on the island- continent, Australia) (Henle and Streit, 1990). This case emphasizes the acuteness of conservation in Israel.

Despite some considerable interest, recently, of the Israeli public in ecology and even herpetology, and in conservation, the ecology and demography of amphibians and, especially, reptiles are known only in the most general terms. There are few hard data on which to base either the planning and management of

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reserves or the regulation and licensing of collecting. But to the extent that herpetological research exists in Israel, most of it is conducted with nature conservation kept in mind.

It is this conservation-oriented herpetological research that we endeavor to review here. We do so on three levels of relevance to conservation: (1) Studies of endangered species: ecology, specific requirements (incubation etc.) and taxonomic definition of taxa for protection. (2) Studies of common species, contributing data to conservation policy. (3) A policy to prefer investigations not requiring the collection of specimens.

METHODS

Literature Presented

We endeavor to represent each project mentioned, by a single major and relatively recent reference. In the text, author names are preceded by abbreviations indicating the institutions involved. When more than one institution is mentioned, the first carries the main responsibility. Unfortunately, the results of many projects were never published; some of these exist as M. Sc. or Ph.D. theses in Hebrew. Rather than either list their details in *References* or else discount them in the text as "unpublished", we mention these in the text as "institution: author, thesis", thus enabling an appeal to the author or institution.

Abbreviations of Institutions

BGUN — Ben Gurion University of the Negev, Beer Sheva, through its Department of Biology.

HUJ — The Hebrew University of Jerusalem, through its Teaching Division of Zoology; Department of Evolution, Systematics and Ecology; and Life Sciences Collections.

IHIC — The Israel Herpetological Information Center of the SPNI in cooperation with HUJ and TAU.

MGTC — MIGAL, Galilee Technological Center, Qiryat Shemona.

NRA — The governmental Nature Reserves Authority, through its Scientific Division.

SPNI — The public Society for the Protection of Nature in Israel, mainly through its IHIC, sometimes through its internal and external research funds.

TAU — Tel Aviv University, through its Department of Zoology and Institute for Nature-Conservation Research.

TIIT — The Technion — Israel Institute of Technology, through its Department of Biology.

RESEARCH PROJECTS

We shall try to classify the research activities by the type of linkage to conservation, as explained in the Introduction, and to present recent major examples.

1. Projects which are Directly Conservation-Oriented

(1a) Field Studies of Endangered Species. The local populations of all amphibians and many terrestrial reptiles exist at the limits of the respective distribution ranges of the species. Hence most amphibians and many reptiles are endangered, at least locally. These species have been protected by law since 1963 and all investigations have been under NRA permits.

Of the amphibians, *Discoglossus nigriventer* is probably extinct and cannot be studied. Besides some studies on variation and especially calls of the common *Bufo viridis*, *Hyla savignyi* and *Rana levantina* ("*ridibunda*"), most field studies have focused on the variation, autecology and population ecology of the three remaining, more highly endangered, species: *Salamandra salamandra* (TIIT: Degani, 1976, 1986a; Warburg, 1994), *Triturus vittatus* (HUJ: Mendelssohn and Steinitz, 1944; Steinitz, 1965; MGTC, TAU, TIIT: Degani and Mendelssohn, 1983; TAU: Geffen et al., 1987), *Pelobates syriacus* (TAU: Gafny, 1986). In addition Degani (1986b) studied resource partitioning among co-existing amphibian larvae.

A few individual marine turtles, *Chelonia mydas* and especially *Caretta caretta*, still nest on Israel's Mediterranean shore. The nests are guarded and monitored by the NRA (NRA annual reports are published in Hebrew).

The total Middle Eastern (Asian) population of the huge freshwater turtle *Trionyx triunguis* has been estimated at 500. In this century *Trionyx* nearly disappeared from Egypt, though it later recolonized Lake Nasser. The species is endangered, despite its ability to survive in the sea (Baha el Din and Salama, 1992; Kasparek and Kinzelbach, 1991). In Israel

Fig. 1. Soft-shelled turtle, *Trionyx triunguis*, feeding on chicken carcasses in the Alexander River, Israel. Photographed April 20, 1988, by Y. L. Werner.

Trionyx survives mainly in the heavily polluted Alexander River, where a population of >200 individuals was artificially fed (Fig. 1), and recently also monitored, till winter 1991/92 (NRA: Shy, 1991). In that rainy winter, violent flooding of the Alexander River decimated its *Trionyx* population to <50.

The small desert-sands tortoise *Testudo kleinmanni*, limited to NE Egypt and SW Israel, and endangered, was studied in both field and laboratory (TAU: Geffen and Mendelssohn, 1989, 1991; Mendelssohn, 1982).

Among the lizards, particularly endangered are the large species, with their sparser populations and greater appeal to commercial collectors. The burrowing and feeding ecology of *Uromastyx aegyptius* has been studied in nature (HUJ and SPNI: Bouskila, 1984, 1986; Foley et al., 1992); so has the behavioral ecology of *Varanus griseus* (TAU: Stanner and Mendelssohn, 1987). One species which is locally gravely endangered but has not been studied is the large green *Lacerta media israelica*, of limited distribution, and populations presumably decimated by feral cats (Mendelssohn, 1992). The little desert-sand gecko *Stenodactylus doriae* is locally endangered because of encroachment on its limited sand habitat; its ecology and demography are being studied extensively (HUJ, SPNI, IHIC: Bouskila, 1987, in MS; Ehrlich, in preparation).

The venomous snakes, likewise a target of commercial collecting, were among the first whose general ecology was studied to some extent (General — TAU: Mendelssohn, 1963, 1965; *Cerastes gasperettii* — HUJ: Shani, 1990; *Walterinnesia aegyptia* — BGUN: Zinner, 1971).

(1b) Laboratory Studies to Define Requirements of Endangered Species. Experimental elucidation of the environmental requirements for successful reproduction, aids both in captive propagation and in the planning of reserves and other conservation measures.

The reproduction of *Salamandra salamandra* (TIIT, MGTC: Degani, 1976, 1984; Degani et al., 1980) and *Triturus vittatus* (TAU: Mendelssohn, unpublished) was studied in the laboratory.

The physiological ecology of nests and eggs of the turtles *Trionyx triunguis* and *Caretta caretta* has

been studied with a view to defining the optimal incubation conditions (TAU: Leshem and Dmi'el, 1986; Leshem et al., 1991; Silberstein and Dmi'el, 1991). In *Trionyx* this has extended to captive breeding and rearing (TAU: Mendelssohn, unpublished).

The breeding, incubation and rearing of *Uromastyx aegyptius* and *U. ornatus*, as well as of many other lizards and snakes, have been monitored in captivity (TAU: Mendelssohn, unpublished).

(1c) Taxonomic Studies to Define Taxa Requiring Protection. In Israeli circumstances, where species may be locally limited to tiny areas, the effective planning of conservation requires precise data on the existence of taxa and on their distribution ranges.

Recently, distinction on the species level was confirmed between two viperid snakes: the Saharan *Cerastes cerastes* and the Arabian *C. gasperettii*. *C. gasperettii* occurs in the limited sands of the 'Arava Valley as a unique population deserving conservation (Werner et al., in press; Werner et al., 1991; Werner and Sivan, 1992).

The service of identifying endemic taxa is sometimes extended to neighbor countries (HUJ: *Laudakia stellio picea* — Werner, 1992; *Cerastes cerastes* n. ssp. from SW Arabia — Werner et al., in press).

Currently three species of snakes which appear to be polymorphic are being examined to verify that each is indeed one species and not a group of sibling species (HUJ: Kark et al., 1997; Wolf and Werner, 1994). In at least one case such a morph has a point-distribution.

2. General Projects which Contribute Data to Conservation Policy

(2a) Studies on Life History and Ecology of Common Species. Because of the importance of amphibians and reptiles in ecosystems (Pough, 1980), data on life history and ecology of non-endangered, and, especially, of common, species, are hoped in the long run to help guide policies of ecosystem management and conservation.

An extensive field study of *Mauremys caspica rivulata* revealed that this freshwater turtle, by invading weirs and oxygenation pools, is spreading southwards, towards the desert (TAU: Gasith and Sidis, 1983, 1985).

The common rupicolous gekkonids of the genus *Ptyodactylus* (*P. hasselquistii* occurs within Israel only near Elat but is not endangered) have been investigated from many aspects (Werner et al., 1993; Werner and Frankenberg, 1981; Werner and Sivan, i1993, 1994). The biology of the tree gecko of Israel, *Cyrtopodion kotschyi*, was also reviewed recently (Werner, 1993). The small lacertid *Mesalina guttulata* is one of the very few reptiles whose ecological study included data on population density (Orr et al., 1979). The ecology and inter-relations of the lacertids *Acanthodactylus schreiberi* and *A. scutellatus* were the subjects of field and laboratory investigations (HUJ: Avital, 1981; TAU: Perry, 1990).

Nocturnal activity in relation to moonlight was studied in several snakes by censusing (SPNI, IHIC: Bouskila, 1989). The thermal and behavioral ecology of the large colubrids *Coluber jugularis* and *Malpolon monspessulanus* were studied by radiotelemetry (TAU: Stanner, 1991).

(2b) Comparative Studies on Life History and Ecology. At Hazeva in the 'Arava Valley a major longitudinal population study of marked individuals of all nocturnal reptiles has been in progress since 1985 (SPNI, IHIC, HUJ: Bouskila, 1987, 1989, MS; Ehrlich, in preparation). Other projects with a comparative rather than specific orientation have been museum-based and are reviewed in the next section.

3. A Policy of Research without Collecting Specimens

(3a) Projects Utilizing Preserved Collections. In principle, once animals have been collected, they should finally be deposited in a museum where they can and should be used and reused to provide as much information as possible. Classically such collections are used to study regional fauna (HUJ, TAU: Sivan and Werner, 1992), zoogeography (HUJ, TAU: Werner, 1988) and geographical variation (HUJ: Werner and Sivan, 1993). But moreover, museum specimens, properly analyzed, can yield important information on life history and ecology, as amply shown by Shine (1981) and Fitch (1985). Local projects which may contribute to conservation include a species-oriented study of the reproductive cycle of the lizard *Laudakia stellio* (TAU, HUJ: Arbel, 1969) and comparative studies of fertility in common lizards of the families Agamidae, Chamaeleonidae, Gekkonidae, Lacertidae and Scincidae (HUJ, TAU: Frankenberg and Werner, 1987, 1992; Werner, 1989; Werner and Frankenberg, 1987; Werner and Lampl, 1992).

(3b) Projects Utilizing Live Collections. Similarly, captive animals should be utilized to generate

useful life history data. Thus, the reptile menagerie at TAU has yielded a plethora of unpublished data (see 1b) and the colony of gekkonid lizards at HUJ has produced reports relevant to conservation on reproduction (Werner, 1986, 1989) and especially physiological longevity (Werner et al., 1993).

(3c) Projects Based on Free Animals. Some investigations on animals in nature do not require their being sacrificed. Animals collected for a study of reptile communities (TIIT: Warburg, 1978) were released again (Warburg, personal communication). The longitudinal study at Hazeva (see 2b) only requires toe-clipping for permanent marking of lizards. But in studies of a gecko rookery (HUJ: Werner, 1986) and of foraging mode of lizards in the field (HUJ: Perry et al., 1990) even this degree of interference was unnecessary.

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