Israel Journal of Entomology
Vol. XXVII (1993) pp. 25–30

THE HULA LAKE LEAF BEETLES REVISITED

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ABSTRACT

Review and some additional records for the previously reported extinction of *Donacia bicolor* Zschach, including the former presence of *D. marginata* Hoppe (not *D. thalassina* Germar), from the Hula Lake and Swamps are provided. *Galerucella nymphaeae* Linnaeus is reported as a second case of extinction from the Hula.

KEY WORDS: Chrysomelidae, *Donacia*, *Galerucella*, Hula Lake, extinction.

INTRODUCTION AND FIRST LEAF BEETLE EXTINCTION

In a previous paper the author reported the former existence and subsequent extinction of *Donacia bicolor* Zschach and *D. thalassina* Germar (Coleoptera: Chrysomelidae: Donaciinae) in the Hula Lake and Swamps prior to the 1951–1958 drainage of this area (Furth, 1977). *Donacia bicolor* is relatively common throughout the Palearctic with a widespread distribution from Europe to Siberia, south to Turkey and the Caucasus; however, its presence in the Hula represented its southernmost extension. The specimen record of *D. thalassina* (Furth, 1977) has recently been redetermined as *D. marginata* Hoppe (I. Askevold, personal communication), never before recorded from the Middle East. This adds an interesting new aspect to the extreme rarity of the *D. bicolor* foodplant *Sparganium erectum*, because *D. marginata* is also known to feed on *Sparganium* in Europe (Mohr, 1966a). *D. marginata* is recorded across Europe to Greece and Asia Minor (= Turkey) as well as in Morocco (Jolivet, 1970). The Hula population of *D. marginata*, like that of *D. bicolor*, represented the southeasternmost record for this species. Both of these pre-drainage records were discovered through examination of historical specimens in university collections. In the case of *D. bicolor*, series of specimens collected by the late Prof. Bytinski-Salz in the Hula during the 1940s included foodplant records (on *Sparganium neglectum* Beeby = *erectum* Linnaeus). The well-documented drainage of the wetlands (lake and swamps) of the Hula and its restoration into a preserve (Paz, 1976) as well as the current very rare status of *S. erectum* provided an obvious answer to the fate of the Israeli population of *D. bicolor* and *D. marginata*, which apparently became extinct through the drainage of the Hula (Furth, 1977). Prior to the Hula drainage, *S. erectum* was found commonly along the western and eastern edges of the Hula Swamps, including in the vicinity of the Enot Einan Spring.

The Hula was drained in order to attempt to eradicate malaria and to reclaim arable land for new settlements. However, by the time drainage began (1951) malaria was at a very low level and the land reclaimed had very limited agricultural use. The biological surveys carried out in the Hula before its drainage provided scientific documentation of the vascular plants (Jones, 1940; Zohary and Orshansky, 1947) and of the vertebrate fauna (for bibliography see Dimentman et al., 1992). Because of this documentation, the effects of the drainage on the vascular plants and vertebrate fauna were known (Paz, 1976; Furth, 1977; Dimentman et al., 1992). Conversely, even though some faunistic surveys had been conducted previous to the drainage (Steinitz et al., 1940–1944) and more recently (Furth, 1981), no comparable surveys of aquatic insects had been published until that of Dimentman et al. (1992), which also includes information (published and unpublished) concerning the pre-drainage biota of the Hula. Some animal extinctions have been well documented but certainly many others have not and may never be (Furth, 1977). Probably the best known documented extinction is that of the endemic frog *Discoglossus nigriventer* Mendelssohn and Steinitz (Discoglossidae).

The only resource for the study of pre-drainage fauna of the Hula Lake and Swamps is from collections made prior to the drainage. Such collections are usually housed in natural history museums, including outside of the region (e.g. the case of *D. marginata* mentioned above). Specimens in collections serve as an historical archive and their value for biological conservation studies is often not fully appreciated even by scientists in related disciplines. In fact, modern molecular techniques such as PCR (Polymerase Chain Reaction) are allowing geneticists to retrieve DNA information from very old specimens housed in natural history collections. Since the case study of *D. bicolor*, the author has spent additional field seasons (1977–1981) in Israel, including extensive surveying of the Hula Preserve for aquatic insects (Furth, 1981). Specific search for the above species of *Donacia* and examination of their currently extremely rare foodplant (*Sparganium erectum*) in the Hula and Dan Nature Reserves yielded nothing. Subsequent aquatic insect surveys by Inland Water Ecological Service (IWES) staff also have not produced any evidence of Donaciinae presence.

Although the idea of preserving part of the Hula Lake and Swamps was agreed upon during the drainage, and the Hula was declared officially as the country's first national preserve in 1964, it was not until 1971 (after the 1968 creation of the Nature Reserves Authority) that a detailed plan of rehabilitation and enlargement of the Hula Reserve began. Between the time the drainage was completed (1958) and the beginning of rehabilitation (1971), a number of significant ecological changes occurred in this wetlands area, i.e. dried former swamp vegetation burned in large parts of the reserve and most of the reserve completely dried up at different points. For certain such traumatic events permanently altered ecological associations and caused extinctions (or extreme rarity) of many plants and animals. The rehabilitation of the Hula was completed by the middle 1970s; however, even though the Hula Reserve includes the Enan Spring, most of the water in the reserve has been polluted/contaminated from surrounding fish ponds. These fish ponds are periodically drained into the shallow Hula Reserve producing a hypereutrophic body of water (Cowgill, 1989a, 1989b). The distinct differences in pre-drainage water quality between the lake and the swamps (more oxygen, higher pH, a wider range of temperature fluctuations, lower salinity and less organic matter in the lake than in the swamps) (Jones, 1940) are now certainly gone. The resulting organic pollution and algal blooms caused by the fish pond water are and certainly have long been detrimental to the preservation of many aquatic ecological associations. This type of pollution must have contributed to the decrease and possible extinction of a number of animals and plants.

THE SECOND LEAF BEETLE EXTINCTION

A second case of an aquatic Leaf Beetle population apparently becoming extinct since and because of the drainage of the Hula wetlands has now been discovered. *Galerucella nymphaeae* (Linnaeus) (Chrysomelidae: Galerucinae) has been recorded throughout Europe (including all the Balkans and Greece), Siberia, Central Asia (including Caucasus and northern Iran), northern China, Mongolia, and throughout North America (Wilcox, 1971; Silfverberg, 1974; Mohr, 1966b). It has not been recorded in Turkey, Cyprus, Syria or Egypt (Aysev, 1972; Georghiou, 1977; El-Hariri, 1968; Alfieri, 1976). This species has been recorded to feed primarily on Nymphaeaceae (i.e. *Nuphar* and *Nymphaea*), especially species of *Nuphar* throughout Europe and North America (Hippa and Koponen, 1986; Juliano, 1988; Kouki, 1991). Extensive bio-ecological studies have recently been carried out on *G. nymphaeae* (Kouki, 1991; Setälä and Makelä, 1991).

In 1987 and 1988 unidentified Coleoptera larvae and adults from the Hula wetlands (lake and swamps) (from the alcoholic collection at the Tel Aviv University) were sent to the author for identification by H.J. Bromley (Hebrew University of Jerusalem), who was studying the invertebrate fauna of the Hula. These specimens were collected by a Hebrew University expedition to the Hula in 1940–1944. The author determined that most of these specimens were *G. nymphaeae* (one was *D. bicolor*). These specimens were all collected in the Hula as larvae (#134, 7 June 1940; #217, 28 October 1940) and adults (#134, 7 June 1940; #168, 28 August 1940; #217, 28 October 1940; #274, 14 March 1941). In addition, Dr. Bromley has determined larvae of *G. nymphaeae* from #326, 19 April 1941 and an adult from the Jordan River entrance to the Hula (20–24 June 1952) (H. Bromley and Ch. Dimentman, *in litteris*). The numbers refer to stations along the northern border of the Hula Lake: 217, 274 and 326 were located where the Enan stream entered and 134 and 168 were located at the Jordan River entrance. The presence of *G. nymphaeae* in Israel has never been recorded; therefore, this is both a first record of its presence and of its extinction there. One sample (#217) was from a jar labelled "from Papyrus heads" and it contained a small piece of a leaf with eggs attached. The author determined that this piece of leaf was not *Cyperus papyrus* Linnaeus and suspected it rather to be Nymphaeaceae. This was confirmed by D. Heller (Hebrew University of Jerusalem) who determined the leaf fragment as the water lily *Nymphaea*, probably *N. alba* Linnaeus. A reasonable assumption is that this leaf fragment represented the plant on which these specimens of *G. nymphaeae* were collected. The eggs also appeared to be those of *G. nymphaeae*. There are only two species of *Nymphaea* in Israel, both extremely rare and on the verge of extinction (Zohary, 1966). The Hula represented the southernmost distribution limit for *N. alba* which was apparently eliminated by the drainage (Paz, 1976; Furth, 1977). The other water lily, *Nuphar lutea* (Linnaeus), still exists in ponds and rivers of northern Israel, as well as in the present Hula Nature Preserve. An unpublished diary of the Hebrew University expedition to the Hula (Steinitz et al., 1940–1944 and H. Bromley and Ch. Dimentman, *in litteris*) states that *G. nymphaeae* was collected from the upper sides of *N. lutea* leaves where they were feeding, and that *Nymphaea* occurred nearby. Reports from unpublished records of the Hebrew University of Jerusalem expedition to the Hula state that the beetles were feeding on *N. lutea* and that *Nymphaea* was nearby (H. Bromley, *in litteris*).

It is interesting to note that only one species of *Galerucella* Crotch has ever been recorded in Israel — *G. setulosa* Sahlberg (Bodenheimer, 1937). Sahlberg (1913) described *G.*

setulosa from a single female specimen collected in the vicinity of Jerusalem on 24 February 1904. This species and its record are suspect by being a single specimen and having never been recorded anywhere since. The author examined the type (from the Helsinki Museum) and agrees with Silfverberg (1974 and *in litteris*) that *G. setulosa* is actually a member of *Lochmaea* Weise rather than *Galerucella*. Actually *Galerucella sensu latu* has been divided into several genera by Wilcox (1965, 1971) and Seeno and Wilcox (1982) so that *G. nymphaeae* is correctly one of the few *Galerucella sensu stricto*.

Hippa and Koponen (1975, 1986) have shown that at least the northern European, and probably some North American, *Galerucella nymphaeae* actually are a complex of species differing in some cases by their foodplant preferences. With such a widespread distribution it seems quite possible that *G. nymphaeae* is a complex of sibling biological species throughout its range. However, proof of this will require much more detailed study similar to that of Hippa and Koponen (1986) as well as genetic and molecular research.

The Hula population of *Galerucella nymphaeae* existed as the southernmost disjunct population of this species in the Old World. It is unfortunate that this outlier population of such a widespread species is apparently extinct, because the possibility to discover whether the Hula population of *G. nymphaeae* was a separate taxon may be lost. The exact cause of apparent extinction for this population in the Hula is not completely clear. If the only foodplant was *Nymphaea alba*, it would be a case identical to *Donacia bicolor* — extinction caused by the near extinction of its foodplant. However, the unpublished records mentioned above indicate that *G. nymphaeae* also fed on *Nuphar lutea*. Since this *Nuphar* is still present in the Hula, it is assumed that some change in the water quality, possibly some aspect of the organic pollution from the fish ponds, has caused the extinction of this beetle population. It is possible that changes in the chemical composition of these perennial plants have created a detrimental effect on the Hula population of *G. nymphaeae*. As suggested by Cowgill (1989b) perennials may accumulate minerals (e.g. Na, Si, Mn) over time. Such accumulation of certain minerals and uptake or production of toxic/repellant substances may have provided even the *Nuphar* with a feeding deterrent effect against *G. nymphaeae*.

Another possibility is that pesticide spraying may have contaminated the Hula water and plants (topically or through uptake) and, therefore, may have had a major role in the extinction of *G. nymphaeae*. Both *Nuphar* and *Nymphaea* are able to take up some pesticides (Cowgill, *in litteris*). Crop dusting aircraft dropped pesticides into the Hula Reserve weekly during 1963 (Cowgill, *in litteris*) and presumably before.

Through such an extinction we have at the minimum lost the genetic diversity of this population of *G. nymphaeae* at the edge of its range. It is quite possible that the loss is greater, i.e. that the Hula population represented an isolated, cryptic, biological sibling species of the *G. nymphaeae* complex. This type of extinction is relevant to modern practice in conservation and population biology concerning aspects of potential reintroduction. It is not completely clear whether an attempted reintroduction of *Galerucella nymphaeae* and its other foodplant, *Nymphaea alba*, into the present Hula Reserve is warranted or would be successful.

ACKNOWLEDGMENTS

This paper is dedicated to the late Prof. G. Evelyn Hutchinson who was both a good friend and a stimulating colleague and whom I first met and worked with in connection with the Hula.

I would like to thank Drs. H.J. Bromley and Ch. Dimentman (Department of Evolution, Systematics, and Ecology at the Hebrew University of Jerusalem) for bringing the specimens of *G. nymphaeae* to my attention and for providing a variety of information (some unpublished). I would also like to thank Dr. David Heller (with assistance from Prof. A. Fahn) for determination of the leaf fragment in sample #217. Dr. Hans Silfverberg (Zoological Museum, Helsinki) was kind enough to send me the type of *G. setulosa* for examination as well as his comments about its taxonomic position. Dr. I.S. Askevold (Florida A. & M. University) kindly redetermined *Donacia thalassina* as *D. marginata* from the author's 1977 Hula paper about that genus. Finally, the author would like to thank Dr. R. Ortal (Israel Nature Reserves Authority) for his assistance as Director of the Inland Water Ecological Service.

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