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DANAUS CHRYSIPPUS (LINNAEUS, 1758) (*Lepidoptera Nymphalidae*)
LARVAE FEEDING ON *CARALLUMA EUROPAEA* (GUSS.)
N.E.Br. (*Asclepiadaceae*) IN LAMPEDUSA ISLAND

SUMMARY

Danaus chrysippus (L.) is a wide-ranging migrant species; it has considerably increased and extended its range in the North African coastal regions in the past two decades, and from there has colonised parts of the south coast of Spain, Corsica, Sardinia, Italy, Malta and Greece. Although it is a polyphagous species its larvae feed on plants which contain cardenolides, especially Asclepiadaceae, Apocynaceae and Moraceae. In this paper we report on a population found in Lampedusa Island which larvae feed on *Caralluma europaea* (Guss.) N.E.Br. (Asclepiadaceae).

Observations were carried out from April 2006 to November 2007, during a multi-year research project on the ecology of *C. europaea* in Lampedusa. The larvae of the population found in Lampedusa Island feed on *Caralluma europaea* (Guss.) N.E.Br. (Asclepiadaceae). Larvae and eggs have been collected to observe development and feeding preferences under controlled conditions. The strict relation between *Danaus chrysippus* and Asclepiadaceae is confirmed and a strong preference for the follicles versus stems has been observed.

RIASSUNTO

Larve di Danaus chrysippus (Linnaeus, 1758) (*Lepidoptera Nymphalidae*) *fitofaghe di Caralluma europaea* (Guss.) N.E.Br. (*Asclepiadaceae*) *nell'isola di Lampedusa*. *Danaus chrysippus* (L.) è una specie ad ampio raggio di migrazione che nell'ultimo ventennio ha notevolmente aumentato la sua distribuzione. Dalle coste nordafricane ha colonizzato parte del sud della Spagna, la Corsica, la Sardegna, l'Italia, Malta e la Grecia. È una specie polifaga, ma le sue larve si nutrono di piante che contengono cardenolidi, specialmente delle famiglie Asclepiadaceae, Apocynaceae e Moraceae. In questa nota gli autori riportano dati su una popolazione ritrovata nell'Isola di Lampedusa le cui larve si nutrono di *Caralluma europaea* (Guss.) N.E.Br. (Asclepiadaceae). Le osservazioni sono state condotte da aprile 2006 a novembre 2007, nell'ambito di un progetto di ricerca pluriennale sull'ecologia di *C. europaea* a Lampedusa. Le larve e le uova di *D. chrysippus* sono state prelevate ed allevate

in condizioni controllate per osservare lo sviluppo e le abitudini alimentari. La stretta relazione tra *Danaus chrysippus* e le Asclepiadaceae è confermata dai nostri dati, che mostrano una spiccata preferenza delle larve nei confronti dei follicoli rispetto ai fusti.

INTRODUCTION

Danaus chrysippus is a wide-ranging migrant species belonging to Danainae, a subfamily of Nymphalidae, tropical butterflies with a complex pheromone biology (FRANCKE, 1989). *D. chrysippus* distribution ranges from Africa to southern Europe (Canary Islands, coastal Mediterranean regions, Turkey), Saudi Arabia, tropical Asia; it is present in Australia and New Zealand too. *D. chrysippus* is polyvoltine and prefers bushy, rocky places, and coastal gullies, usually near gardens and cultivated areas (PERKOVIĆ, 2006).

Warming trends at lower latitudes seem to be associated with movements of tropical species into more-temperate areas. In the past two decades *D. chrysippus* has considerably increased and extended its range in the North African coastal regions, and from there has colonised parts of the south coast of Spain, Corsica, Sardinia, Sicily, Italy, Malta and Greece (BURTON, 2001). The first European population established in southern Spain in 1980 and by the 1990s had established multiple, large metapopulations (PARMESAN, 2006). The first record for *D. chrysippus* in Sicily dates back to 1983 (GATTO, 1985). The biology of this species is influenced by the availability of larval food-plants. Although it is polyphagous, its larvae feed on plants which contain cardenolides, especially Asclepiadaceae, Apocynaceae and Moraceae (ACKERY & VANE-WRIGHT, 1984). In this paper we report on a population found in Lampedusa Island which larvae feed on *Caralluma europaea* (Guss.) N.E.Br. (Asclepiadaceae).

NOTES ON THE STUDIED SPECIES

Danaus chrysippus (Linnaeus 1758) (Nymphalidae).

D. chrysippus adults reach a wingspan of 58 mm, the ground colour of the fore-wing and the hind-wing upper-side is light orange-brown to chestnut brown, while fore-wing upper-side apex is dark brown with transverse white spots (Fig. 1) (PERKOVIĆ, 2006).

The male scent-producing organs consist of abdominal hairbrushes and alar- or patch-like glands. Males and females are known to accumulate pyrrolizidine alkaloids from plants. The males metabolize these in parts to



Fig. 1 — Specimen of *Danaus chrysippus* from pupa reared in laboratory (Photo: P. Zito).

volatile dihydropyrrolizines, some of which may play a specific role in courtship behaviour (FRANCKE, 1989).

The caterpillar has five larval instars and is about 5 cm long just before pupating. It has black and yellow bands and three pairs of fleshy filaments, one pair, the longest, just behind the head, the second near the start of the abdomen and the third near the end of the abdomen. The base of the filaments is red, and they function as sense organs. Caterpillars accumulate poisonous chemicals from the plants they feed on and are unpalatable to predators. Their striking habitus therefore is a form of warning aposematic coloration (Fig. 2) (BRANDES, 2005).

The pupae are pale green with golden spots and hang head down from a silken pad (Fig. 3). The eggs are silvery white, shiny, bullet-shaped with an apical point and ribbed sides (Fig. 4). The shell is lined with a layer of wax, which helps keep the egg from drying out.

Caralluma europaea (Guss.) N.E.Br. (Asclepiadaceae)

C. europaea is a stem- succulent plant belonging to the family Asclepiadaceae. Some authors suggest that Asclepiadaceae should be merged into Apocynaceae (SENNBLAD, 1996; OLMSTEAD *et al.*, 1993). Even so most papers



Fig. 2 — Larva of *D. chrysippus* feeding on stem of *C. europaea* under laboratory condition (Photo: P. Zito).

dealing with the ecology and taxonomy of the family (e.g. ALBERS & MEVE, 2002) still recognise and use Asclepiadaceae as a valid family. In this paper Asclepiadaceae are being treated as a family, in accordance with ALBERS & MEVE (2002), and OLLERTON (2003). *C. europaea* has quadrangular stems, the younger ones are green and have small leaves that soon wither while the old-



Fig. 3 — Pupa of *D. chrysippus* from eggs collected in Lampedusa and reared in laboratory (Photo: P. Zito).

Fig. 4 — Egg of *D. chrysippus* on the follicle of *C. europaea* photographed in the field (Photo: P. Zito).



est ones look greyish. It forms large clumps up to 15-20 cm in diameter. Flowers are red-brown with yellow stripes or streaks, 10-15 mm in diameter. The corona is normally purplish (Fig. 5) (SAJEVA & COSTANZO, 1994). Fruits are follicles that at maturity dry out. Plants growing in rock crevices usually have a central erect stem and many smaller ones more or less procumbent, while



Fig. 5 — Flowers of *C. europaea* (Photo: P. Zito).

those growing under bushes grow more chaotically (SAJEVA, 1984). The taxonomy of *C. europaea* has been changed by several authors, as it often happens in succulent plants groups; according to WHITE & SLOANE (1937) the species includes 5 varieties (var. *marmaricensis*, var. *simonis*, var. *maroccana*, var. *affinis*, and var. *confusa*), while more recently MEVE & HENEIDAK (2005) use the binomial *Apteranthes europaea* (Guss.) Plowes and recognize two varieties (var. *europaea* and var. *judaica*).

MATERIALS AND METHODS

Observations were done during a multi-year research project on the ecology of *C. europaea* in Lampedusa started in April 2006. Information in the present paper is updated to November 2007. Lampedusa lies in the Mediterranean sea and the studied sites are Isola dei Conigli, Albero Sole, Capo Grecale, Cala Galera (Fig. 6).

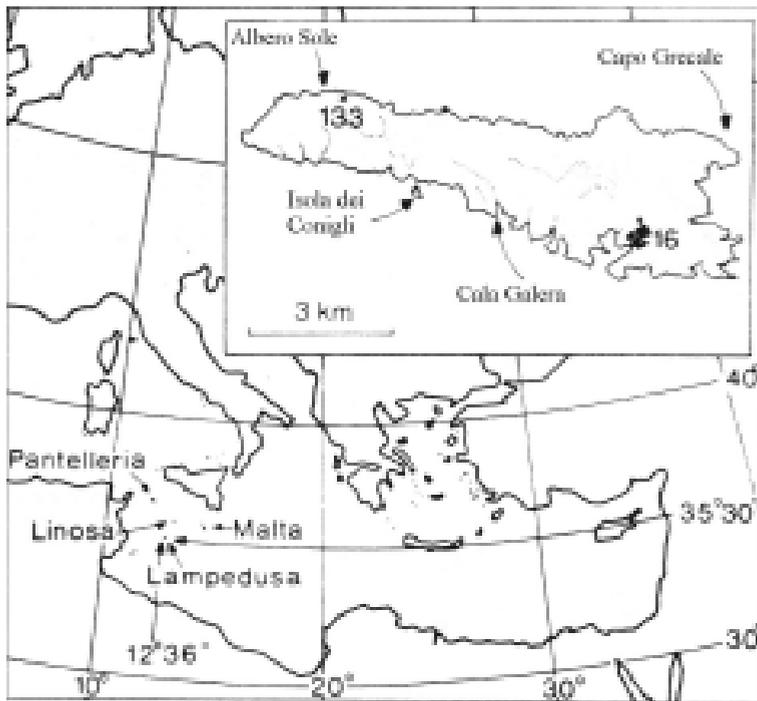


Fig. 6 — Map of the Mediterranean sea, showing the position of Lampedusa. The inset map of the island shows the highest point (133 m) on the north coast and the localities where observations were carried out.

From May to September 2007 we found adults of *D. chrysippus* along the whole island with Isola dei Conigli being the area with highest abundance. Larvae and eggs were present during May and June 2007 only at Albero Sole and Isola dei Conigli. Larvae were feeding on *C. europaea* which grows well camouflaged in rock crevices or among *Thymus capitatus* (L.) Hoffmanns et Link bushes (Fig. 7). We did not find pupae on *C. europaea* nor on any other plants.

Five larvae and five eggs have been collected monthly to observe the feeding behaviour. Eggs and larvae were reared in plastic boxes placed in a thermostated room at 25 ± 2 °C illuminated with $100 \mu\text{mol m}^{-2}$ flux and a photoperiod of 16/8 light/dark hours. To study food preference, as source of food they were supplied with stems, follicles or stem with follicles of *C. europaea* collected in Lampedusa and cultivated at the Botanical Garden of Palermo. The process of complete metamorphosis of *D. chrysippus* has been observed in controlled conditions. After the emergence, the adults were mounted and stored in entomological boxes at the Dipartimento di Scienze Botaniche.



Fig. 7 — *C. europaea* and *T. capitatus* in Lampedusa Island (Photo: P. Zito).

RESULTS AND DISCUSSION

Since 1988, a remarkable increase in the distribution range of the *D. chrysippus* has occurred in Italy. It has been recorded in the whole Sicily, Campania, Lampedusa, Sardinia, Isole Ponziane, and also in Emilia-Romagna and Liguria, the northernmost sightings in Europe (BORGO *et al.*, 1992). The diffusion of the species was linked with the warm conditions occurred from 1986-1990 (PERKOVIĆ, 2006).

Between 1988 and 1991 *D. chrysippus* has been found along the northern coast of Sicily, from Terrasini to the mouth of Imera river, in the southwestern coast from Mazara del Vallo to Torre Salsa and in the eastern coast near Aci S. Antonio, the mouth of Simeto river and Siracusa (ARNONE & ROMANO, 1991). The presence of adults of *D. chrysippus* in Lampedusa has been reported for the first time on June 1988 in the area of vallone Imbriacola, and after that on April and July 1990 (ROMANO & ROMANO, 1995).

In the studied period *C. europaea* was the only food source for the larvae of *D. chrysippus*. During the field observations the eggs have been found only on the suture line of the follicle. The female perches on the follicles and, curling its abdomen around the edge, lays an egg on the follicle. *D. chrysippus* usually lays their eggs singly (ACKERY & VANE-WRIGHT, 1984). Eggs hatch about four days after laying. Each follicle hosted 1 to 6 eggs and on each plant a maximum of three larvae have been counted. Larvae were feeding primarily on follicles, and used stems only after complete consumption of the follicles of the host plant (Fig. 8).

Under our controlled conditions in the presence of stems with follicles the larvae fed on follicles first and ate the stems only when follicles were no more available.

The entire larval stage lasts from nine to fourteen days. In our conditions the time from laying to eclosion is 2-4 days. Larvae fed for about 10 days and reached a length of about 5 cm, in ten days growing from 4.5 to 50 mm. On reaching maturity, the caterpillars left the foodplants to search for suitable pupation sites. Under laboratory condition the larvae silked a pad of silk and clinged head downwards by means of the anal claspers on the lid of the boxes (Fig. 3). The pupal development period depends on conditions of light, temperature and humidity (ACKERY & VANE WRIGHT, 1984); in our condition it took 8-10 days.

Butterflies of the subfamily Danainae become unpalatable to predators when their larvae feed on plant species containing cardiac glycosides (cardenolides) (MEBS *et al.*, 2005). Danainae biological cycle is linked mainly to Asclepiadaceae, Apocinaceae and Moraceae (ACKERY & VANE-WRIGHT, 1984).

The larvae of *D. chrysippus* feed mainly on Asclepiadaceae, from which they store cardenolides. Other families involved, according to VANE-WRIGHT & DE JONG, (2003) are: Convolvulaceae, Euphorbiaceae, Sapindaceae, and



Fig. 8 — Caterpillars of *D. chrysippus* feeding on follicles of *C. europaea*. (Photo taken in laboratory: P. Zito).

Plumbaginaceae. Among Asclepiadaceae the following taxa have been reported as host plants for larvae of *D. chrysippus*: *Asclepias*, *Aspidoglossum*, *Brachystelma*, *Calotropis*, *Caralluma*, *Ceropegia*, *Cynanchum*, *Gomphocarpus*, *Huernia*, *Ischnostemma*, *Kanabia*, *Leichardtia*, *Leptadenia*, *Marsdenia*, *Metaplexis*, *Pachycarpus*, *Pentarrhinum*, *Pentatropis*, *Pergularia*, *Periploca*, *Pleurostelma*, *Raphistemma*, *Rhyncharrhena*, *Sarcostemma*, *Schizoglossum*, *Secamone*, *Stapelia*, *Stathmostelma*, *Tylophora* (ACKERY & VANE-WRIGHT, 1984; VANE-WRIGHT & DE JONG, 2003). Within the genus *Caralluma*, only *C. burchardii* (BRANDES, 2005) has been recorded at specific level as forage plant for *D. chrysippus*. Our record is the first for the species *C. europaea* as fodder for *D. chrysippus*.

The genus *Periploca* has been described as foodplant for *D. chrysippus* (VANE-WRIGHT & DE JONG, 2003) and it is represented in Lampedusa by *Periploca angustifolia*. It is interesting to note that no larvae have been found feeding on it. This may be related to the different phenology of the two Asclepiadaceae species. According to PIGNATTI (1982) *C. europaea* blooms and sets fruits between April and July, while *P. angustifolia* blooms and set fruits between November and March. During our field research *C. europaea* had the maximum fruit production in April and May, while *P. angustifolia* had follicles in February and March. We found eggs and larvae in *C. europaea* only when follicles were

present, that is from May to June 2007 (Tab. 1). It is possible that the first generation of *D. chrysippus* arrives from Africa helped by the strong winds from the south-east quadrant which are prevailing in April (data kindly supplied by ENEA). On its arrival it lays eggs on the follicles present, those of *C. europaea* at that time. Larvae feed on follicles and stems. At the end of pupate period there

Table 1
Presence (•) of follicles of *Caralluma europaea*, of *Periploca angustifolia*, of adults and larvae of *Danaus chrysippus* in Lampedusa island during the observation period. All the larvae found were feeding on follicles of *C. europaea*.

Year	2006										2007									
Month	A	M	G	L	A	S	O	N	D	G	F	M	A	M	G	L	A	S	O	N
Follicles <i>C. europaea</i>	•	•	•	•									•	•	•	•				
Follicles <i>P. angustifolia</i>										•	•	•								
Larvae <i>D. chrysippus</i>														•	•					
Adults <i>D. chrysippus</i>														•	•	•	•	•		

is the emergence of second generation, and new eggs are laid on follicles. In this way it seems that the biological cycle of *D. chrysippus* in Lampedusa is strictly linked to *C. europaea*. From our observation and available data it seems that *D. chrysippus* is present in Lampedusa only as a migrant species; in fact its presence is not constant through the years. Our data give a strong confirm to the relation between Danainae and Asclepiadaceae and increase the number of known species on which *D. chrysippus* larvae feed. *P. angustifolia* could be an alternative food source in the event of a early migration of *Danaus* in Lampedusa.

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