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Contribution to the knowledge of Cybocephalid beetles Biology and ethology of *Cybocephalus freyi* Endrödy-Younga(*)

Abstract - Cybocephalid beetles are predators of armored scale insects. Up to the present they have been poorly studied in Italy. In this paper we give notes on the biology and the life cycle of *Cybocephalus freyi* Endrödy-Younga, a species common in Sardinia and Liguria.

Riassunto - *Contributi alla conoscenza dei Coleotteri Cibocefalidi. Note biologiche ed etologiche su* Cybocephalus freyi *Endrödy-Younga.*

I Coleotteri Cibocefalidi sono predatori di diaspini poco studiati in Italia. Si forniscono note sulla biologia e sul ciclo di *Cybocephalus freyi* Endrödy-Younga, presente in Sardegna ed in Liguria.

Key words: Cybocephalidae, *Cybocephalus freyi,* Diaspididae, Biological control.

Cybocephalids are small size beetles, widely distributed all over the World (Endrödy-Younga, 1968; 1971a; 1971b; 1979; 1984). Up to the present about 150 species and 4 genera (*Cybocephalus* Erichson, *Hierronius* Endrödy-Younga, *Pastillodes* Endrödy-Younga and *Horadion* Endrödy-Younga) have been discovered. Only 15 species belonging to the genus *Cybocephalus* Erichson are known in Italy (Endrödy-Younga, 1968; Angelini *et al.*, 1995; Lupi, 2002) (Tab. 1).

Several studies on the biology of *Cybocephalus nipponic*us (Alvarez & Van Driesche, 1998a; 1998b; Alvarez *et al.*, 1999), *C. nigriceps nigriceps* (Blumberg, 1973; 1976), *C. micans* Reitt (Blumberg & Swirski, 1982), *Cybocephalus semiflavus* Champion (Ahmad, 1970) *C. binotatus* Grouvelle and *C. aegyptiacus* (Blumberg & Swirski, 1974) have been made in Israel, Pakistan, Japan and America. In our country only the species *Cybocephalus rufifrons* Reitter has been studied by Silvestri (1910) and De Marzo (1991; 1995).

Literature reports that Cybocephalidae are active scale predators in both the larval and adult stages (Endrödy-Younga, 1968; Blumberg & Swirski, 1974; 1982). When needed they can also eat other little arthropods such as mites and first instar larvae of

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Table 1 - Cybocephalid beetles in Italy and their distribution (Angelini et al., *1995; Lupi, 2002).*

Species	Distribution
- *C. diadematus* Chevrolat 1861	Si
- *C. festivus* Erichson, 1845	N - S
- *C. fodori* Endrödy-Younga, 1965	N - S
- *C. freyi* Endrödy-Younga, 1965	N - Sa
- *C. heydeni* Reitter, 1875	N
- *C. micans* Reitter, 1875	S
- *C. nigriceps* (J. Sahlberg), 1908	Si
- *C. nipponicus* Endrödy-Younga, 1971	N
- *C. planiceps* Endrödy-Younga, 1968	N
- *C. politissimus* Reitter,1898	N - S
- *C. politus* (Gyllenhal, 1813)	N - S
- *C. pulchellus* Erichson, 1845	N
- *C. rufifrons* Reitter, 1874	N – S – Si Sa
- *C. similiceps* Jacquelin DuVal, 1858	N
- C. *wollastoni* H. Linderberg, 1858	Sa

North = N; South= S; Sicily = Si; Sardinia = Sa

coccids, but they cannot completely develop on them. Nevertheless one species, *Cybocephalus aleyrodiphagus* Kirejtshuk, James & Heffer, able to develop on *Orchamoplatus citri* (Takahashi) (Hemiptera: Aleyrodidae) has been recently discovered in Australia (Kirejtshuk, James & Heffer, 1997).

As the species of this family are similar in shape, color and size, their classification is based on male genitalia and in particularly on *edeago* and *pars basalis* shape. Due to their small size, they are dissected under a stereomicroscope and genitalia are prepared on slides (Smirnoff, 1954). However, a first classification can be made, observing adult's colours: some species have metallic sheen, others are completely black or dark brown, in others males have yellow or red head and, sometimes, *pronotum.*

The aim of this study was to obtain basic data on the biology of *Cybocephalus freyi* Endrödy-Younga, a species widely distributed in Liguria and Sardinia. This species presents sexual dimorphism: males have a reddish brown head, pronotum and elytra dark brown, antenna and legs yellowish brown, penis and basal plate have the shape represented in figure 1; females are similar to male except from the head wich is dark brown (Fig. 2A-B).

MATERIALS AND METHODS

Bioetology

The study on *C. freyi* biology has been started with individuals found in Andora (SV) in Liguria on pricky pears (*Opuntia ficus indica* L.) infested by *Diaspis echinocacti (*Bouché).

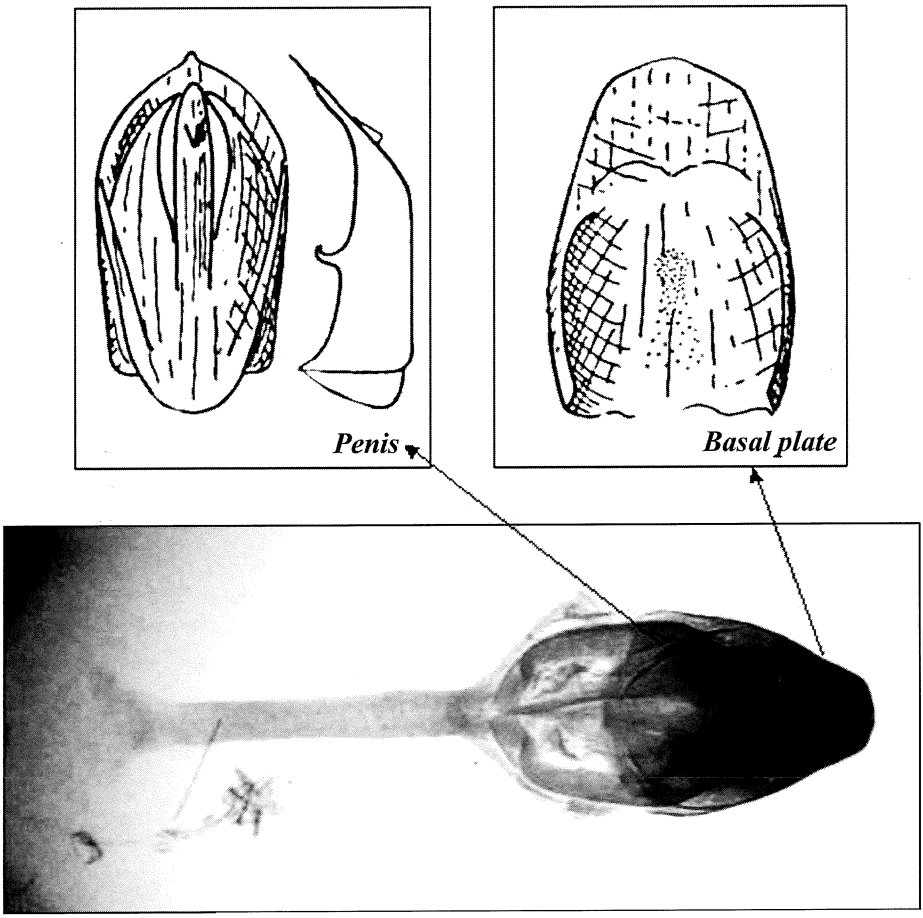


Fig. 1 - *Cybocephalus freyi*: penis and basal plate (Endrödy-Younga, 1968) (at the top); male genitalia slide (at the bottom).

All observations have been carried on in artificial conditions into Plexiglass boxes at 22±1°C, 75% R.H., 14:10 (Light: Dark) and 28±1°C, 75% R.H. 14:10 (Light: Dark).

Biological cycle

Eight ventilated plexiglass boxes (20x20x30 cm) have been prepared for each climatic condition. A pricky pear, infested by *D. echinocacti* and two couples of just emerged *C. freyi* adults were put into each box. Pricky pear stems were observed daily under a stereomicroscope to detect the first ovipositions. After the first egg was seen, the adults were left into the boxes for two more weeks and then removed. The main

purpose of this operation was to verify how long it took from oviposition to emergence.

Small plastic cages (14x7x7 cm) containig some adults and a small pricky pear completely covered with scales were prepared to detect the duration of egg development. Adults were removed 24 hours later and scales were examined under a stereomicroscope to find *C. freyi* eggs. The eggs were taken off and put into Petri dishes on an isoosmotic *substratum* to prevent their dehydration. Some of them were put into a climatic cell at 22±1°C and some others at 28±1°C. They were checked every day until their hatch.

Newly hatched larvae were transferred into plastic cages on a small prickly pear in order to collect more information about larval and pupal stages. Larval development has been checked daily under a stereomicroscope until pupation. Subsequently pupae have been checked until emergence.

Abgrallaspis cyanophilli Signoret, *Diaspis echinocacti* (Bouché), *Unaspis euonymi* (Comstock), *Chionaspis salicis* L., *Aonidia lauri* Bouchè, *Pseudaulacaspis pentagona* Targioni-Tozzetti and *Quadraspidiotus perniciosus* Comstock were given to *C. freyi* in order to evaluate its ability to feed on different species.

Small plastic cages were prepared to evaluate the number of scales daily eaten by the predator. Pieces of pricky pear stems, infested with a known number of second instar or adult females, was inserted in each cage with 4 individuals of *C. freyi* every day. Untouched diaspids were counted 24 hours later. The number of eaten diaspids was calculated by difference.

All data were analyzed according to the Analysis of Variance (AOV) and a Duncan's multiple range test was used to separate means into significant ranges when a significant AOV was obtained ($P > 0.05$ used Throughout).

RESULTS AND DISCUSSION

Bioetology

By an accurate observation with the stereomicroscope it was possible to observe *C. freyi* adults moving on the infested material touching the ground with antenna. Sometimes they stopped to touch a scale and, if they want to eat, they bended their head to make a hole into the scale covers with their mandibles (Fig. 2C-D). During this initial fase of predation *C. freyi* stops frequently, moves back, and removes from its head, antenna and mouth some piecies of the scale covers. When the scale cover is completely opened *C. freyi* can eat the scale body.

If a predator finds a crawlers on the infested surface preys upon it ignoring adult scales; if it finds only adult females with eggs, it only eats the eggs leaving the body of the mother untouched. The female left under the gnawed scale covers died for dehydration. *C. freyi*, like others Cybocephalids (Alvarez & Van Driesche, 1998b), generally lays its eggs singly under female scales without chewing it. Only when just few

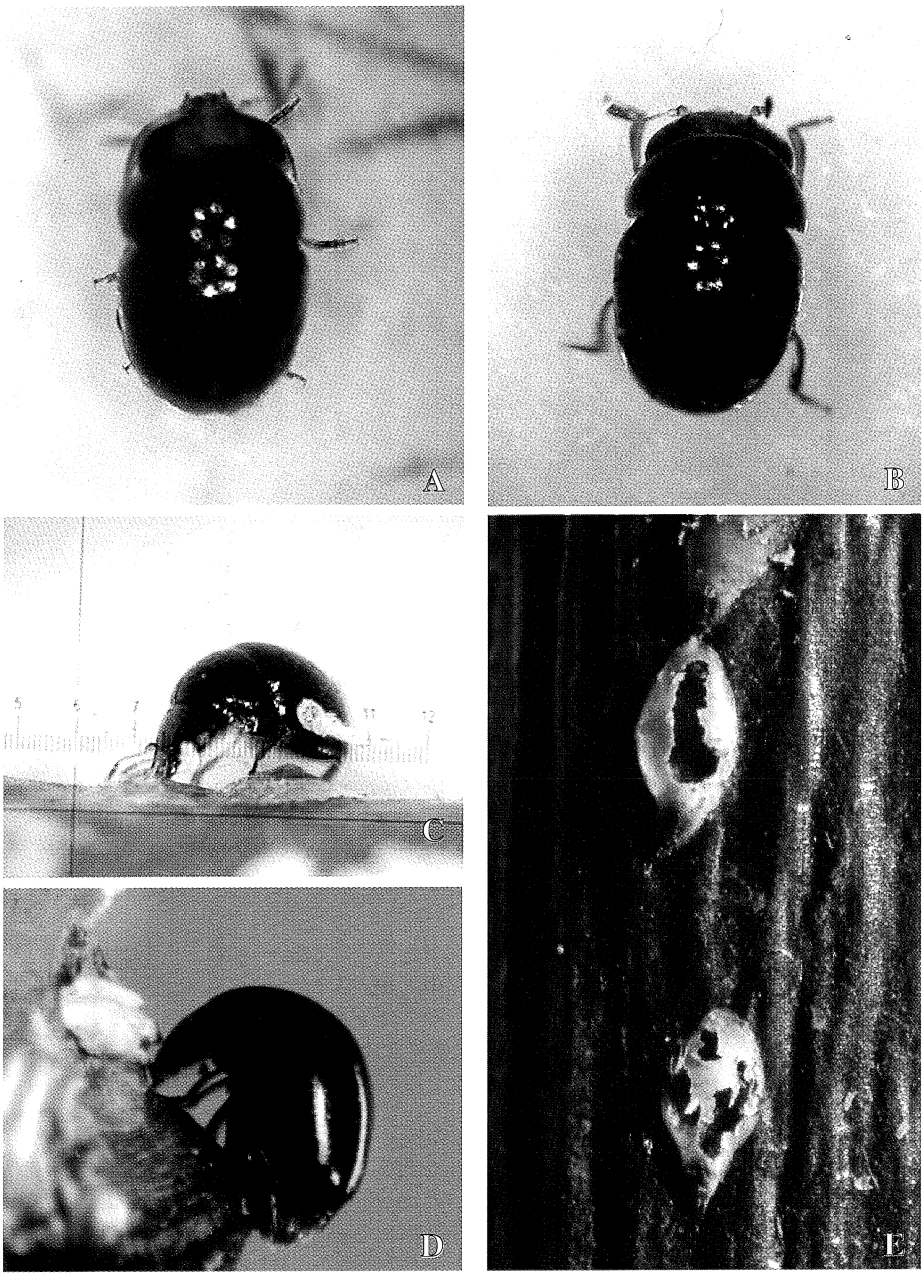
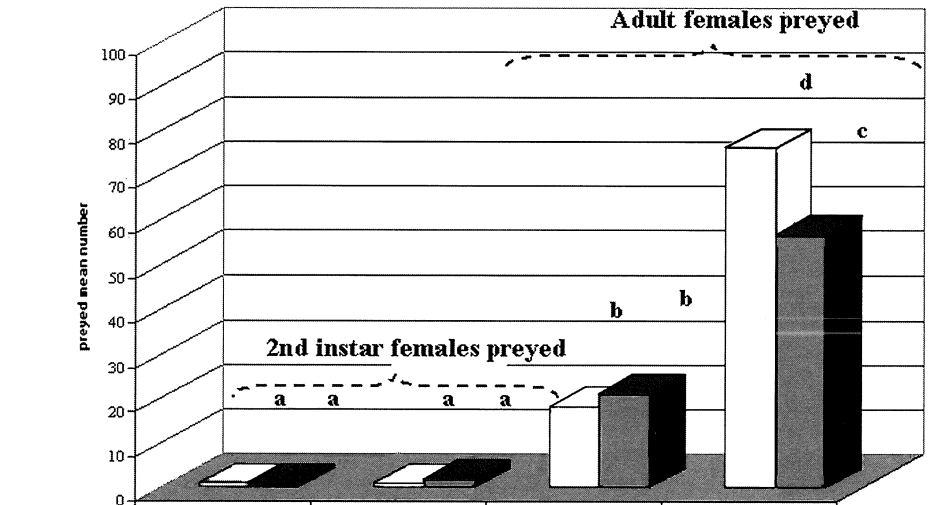


Fig. 2 - *Cybocephalus freyi:* male (A); female (B); female preying upon *D. echinocacti* (C) and *U. euonymi* (D); effect of predation on C. *salicis* (E).



	23 °C	30° C	23 °C	30° C
C.freyi males	0.96	0.92	18.43	76.05
C.freyi females	0.74	1.91	20.86	56.60

Fig. 3 - Mean number of *D. echinocacti* 2nd instar and adult females daily preyed in laboratory by *C. freyi* adults (male and female) at two different temperatures. Letters in the hystogram point out selectivity at Duncan's Test ($P > 0.05$ %).

scales are available it lays them in couple. The scale protect the egg and furnishes food to the newly hatched larva.

Larvae move on the plant from a scale to another only when they are searching a new prey. It is easy to see them are half covered by the scale they are eating.

Third instar larvae stop feeding and move to the ground to pupate, rarely they pupated directly on the plant surface or on the plastic cage bottom.

Cycle

At 22±1°C, 75% R. H. and 14:10 (L:D) the newly emerged adults laid their first egg after 11-13 days. Larvae hatched 8-9 days after, and they developed in 16-17 days. Then they went to the ground where they pupated two days after. Adults emerged 16-17 days after pupation. At this temperature *C. freyi* developed from egg to maturity in 44±2 days.

At 28±1°C, 75% R. H. and 14:10 (L:D) the cycle was really shorter: adults laid their first egg just after 2 days from their emergence. Larvae hatched in 6 days, they developed in 10-11 days and they pupated the day after they had gone to the ground. Adults emerged 10-11 days after. The whole cycle was completed in 28±1 days.

Eggs have an elliptic shape and a smooth transparent surface. They are dark red when just laid but they turn pale after few days, leaving the still developing embryo visible (Fig. 4).

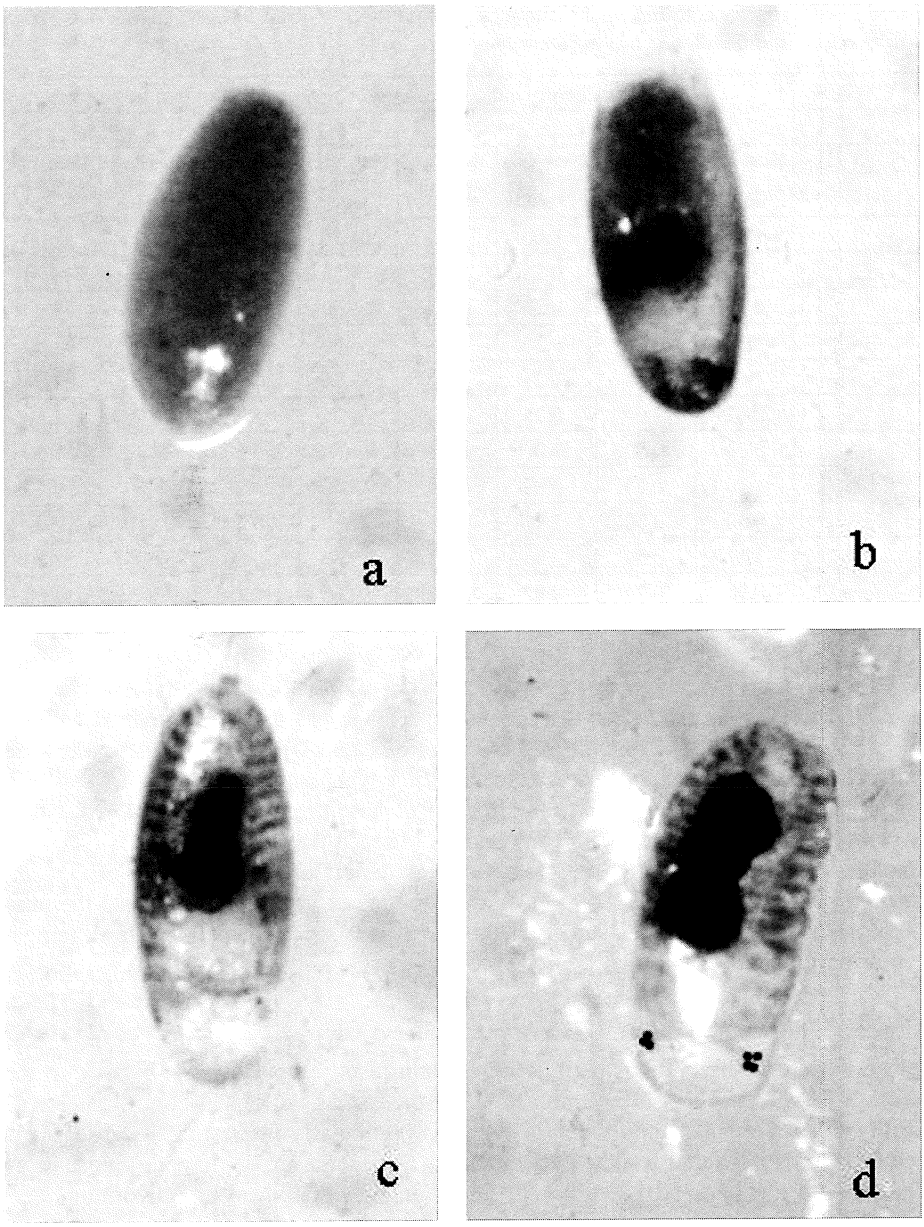


Fig. 4 - *Cybocephalus freyi* egg development: just laid (a); before hatching (d).

Table 2 - D. echinocacti *2nd instar and adult female daily preyed in each cages by* C. freyi *adults (male and female) at two different temperatures.*

CAGES	Adult females preyed				Second instar female preyed			
	23 °C		*30°C*		*23 °C*		*30°C*	
	Mean daily preyed by males	Mean daily preyed by females	Mean daily preyed by males	Mean daily preyed by females	Mean daily preyed by males	Mean daily preyed by females	Mean daily preyed by males	Mean daily preyed by females
1	1.50	0.42	1.00	2.00	24.25	12.25	74.00	55.00
2	0.50	1.25	0.25	2.00	19.25	17.00	87.50	53.00
3	0.75	0.00	0.50	1.33	22.50	17.75	74.00	75.00
4	1.00	0.25	0.50	1.33	24.50	17.50	77.50	48.50
5	1.67	0.75	1.25	1.50	22.00	17.75	71.50	62.50
6	0.67	3.00	0.75	2.00	18.25	23.25	76.50	54.50
7	0.33	0.50	1.00	1.33	14.50	15.50	95.50	51.50
8	1.50	0.25	0.83	2.33	15.00	24.25	89.50	50.50
9	0.50	0.50	1.11	3.33	27.50	19.50	62.50	57.00
10	1.17	0.50	2.00	2.33	20.86	19.50	52.00	58.50
mean	0.96	0.74	0.92	1.95	20.86	18.43	76.05	56.60

Predation

C. freyi was able to eat all the diaspids species it was given. If provided with all the scales stages it always preferred crawlers or eggs, when only adult scale were preyed, it preferred female. Males were eaten just when anything else to eat was left.

Figure 2E gives evidence to the effect of *C. freyi* predation on C. *salicis* scales: every scale was gnawed to permit the beetles to reach the prey.

Results in table 2 and figure 3 refers to daily predation tests. The number of *D. echinocacti* preyed adults doesn't vary according to the sex of the predator or to the temperature. The number of second instar larvae eaten is strictly dependent from temperature and increases with it.

Discussion

Laboratory observations permitted to obtain results about *C. freyi* behaviour and cycle. The insect seems to be interesting for the use as biological control agent. Its ability to prey mainly upon juvenile stages is particularly interesting because it can reduce the damage due to new generations. At the same time, gnawing the scale to find the eggs, it indirectly destroys the adult female which dies for dehydration.

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