Proc. 16th Europ. Coll. Arachnol. | 151-164 | Siedlce, 10.03.1997

Egg sac structure and further biological observations in *Comaroma simonii*[1] Bertkau (Araneae, Anapidae)

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Key words: Araneae, Anapidae, *Comaroma*, behaviour, ecology, reproduction.

ABSTRACT

Specimens of *Comaroma simonii* Bertkau from Styria (Austria) were kept in the laboratory in order to investigate biological details. Egg sacs were built at the end of June and the beginning of July. They were white-coloured, round in shape with a diameter of 1.47 mm on the average (n = 5) and were attached to vertical surfaces. Each egg sac contained three eggs of pale yellow colour. Normally the egg sac is protected by a silken funnel ending in a tube that points toward the ground underneath. It is assumed that this functions as a means of protection against egg predators and parasites. Spiderlings hatched after 27 days; they most probably moulted twice before leaving the cocoon on the 35th day. They built webs closely resembling those of the adults. Juveniles and subadults showed no sclerotization of the body and were rarely found in the natural habitat. There, vertical and horizontal migrations probably occur as a means of avoiding wetness or drying out, respectively. The sex ratio of all collected specimens was 98 females to 54 males. *C. simonii* is regarded as a 'k-strategist' and an eurychronous species.

INTRODUCTION

The biology of Anapidae is insufficiently known. For example, data on egg sacs or juveniles are fragmentary (Hickman 1938, 1943; Platnick & Shadab 1978; Coddington 1986; Eberhard 1987). Moreover, little information is available on the European species *Comaroma simonii* Bertkau, 1889 (Thaler 1978 [with review of previous literature]; Schuster & Moschitz 1984; Kropf 1990a, b, 1993). This paper attempts to describe more biological details of *C. simonii* in order to contribute to an understanding of the habits and ecology of this remarkable anapid spider and to improve our knowledge about non-morphological traits within the spider family Anapidae.

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[1] Species name according to the original description by Bertkau (1889: 74 sub '*Comaroma Simonii*').

MATERIAL AND METHODS

152 adult and several juvenile specimens of *C. simonii* were collected by hand with the help of a soil-sieve in a beech-forest (*Fagus sylvatica*) near the village Hieflau in northern Styria (south-eastern part of Austria) from June 1987 to January 1990. Only very few specimens were caught in pitfall traps, although *C. simonii* is abundant in this locality. Adults were kept in groups of three females and two males on pressed beech humus soil in plastic boxes (10 x 7 x 5 cm). The conditions were full moisture, 18 °C and darkness. Spiderlings were kept under the same conditions; one subadult male and several adult specimens were kept under 15 °C and dim light (other conditions same as above; chapters V and VI). Small arthropods from the natural habitat were offered for prey, mainly Collembola (Kropf 1990a). Spiders and egg sacs were observed in the laboratory by use of a stereo-microscope.

RESULTS

I. Egg sac

Two egg sacs were built in each of two boxes during the night from 29th to 30th of June 1988. During the night from 1st to 2nd of July 1988 another one was built with a thinner silken wall than the others. The egg sacs were white-coloured, of a roughly circular shape and attached to a vertical surface, i.e. the wall of the rearing box (Figs. 1, 2). Anchoring threads were running from the flat base of the egg sac to the substratum. Some other threads connected the upper side to the substrate. The egg sac was anchored by some additional colourless threads being tightened over it. The widest diameter ranged from 1.44-1.50 mm (average 1.47 mm; n = 5). The greatest height ranged from 0.64 to 0.91 mm (av. 0.76 mm). The silken threads of the egg sac were irregularly arranged and varied in strength; some of them were coiled to a strand (Fig. 3). Each egg sac contained three eggs of pale yellow colour with a diameter ranging from 0.35 to 0.37 mm.

Two of the egg sacs were protected by a silken funnel of slightly rose-red colour (Figs. 1b, 4). The funnel continued and ended in a tube that attached to the substratum. The length of this tube seems to depend on the distance to the ground underneath. It is assumed that this functions as a means of protection against egg predators and parasites: Several times I observed, that Collembola were trying to approach the egg sac but were hindered by the protecting funnel or tube.

The egg sac built last and one of the others were without a funnel. The fifth egg sac had a silken funnel and tube built as described before adjacent to it. I assume that this does not correspond to natural conditions but that normally the egg sac is protected by a silken funnel in the above described manner. The egg sacs were not guarded by the adults.

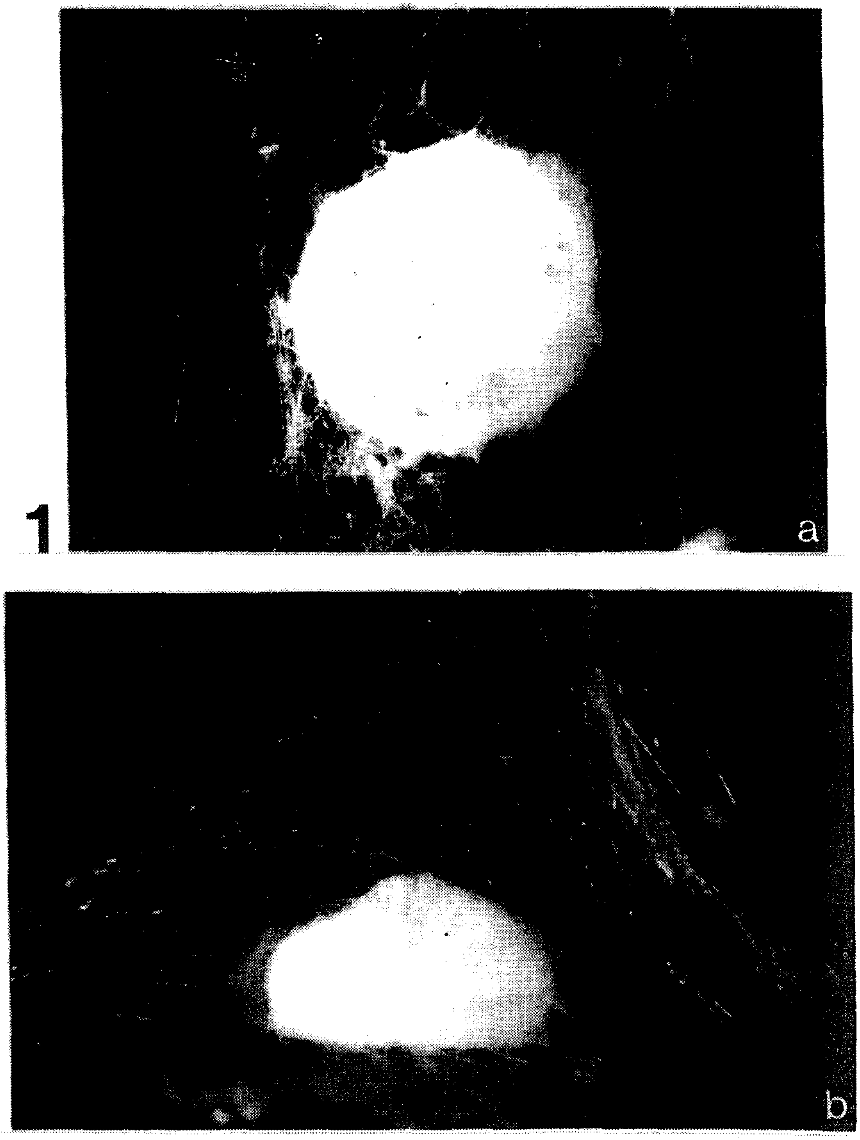

Fig. 1: Egg sac of *Comaroma simonii*; upper view (a), lateral view (b).

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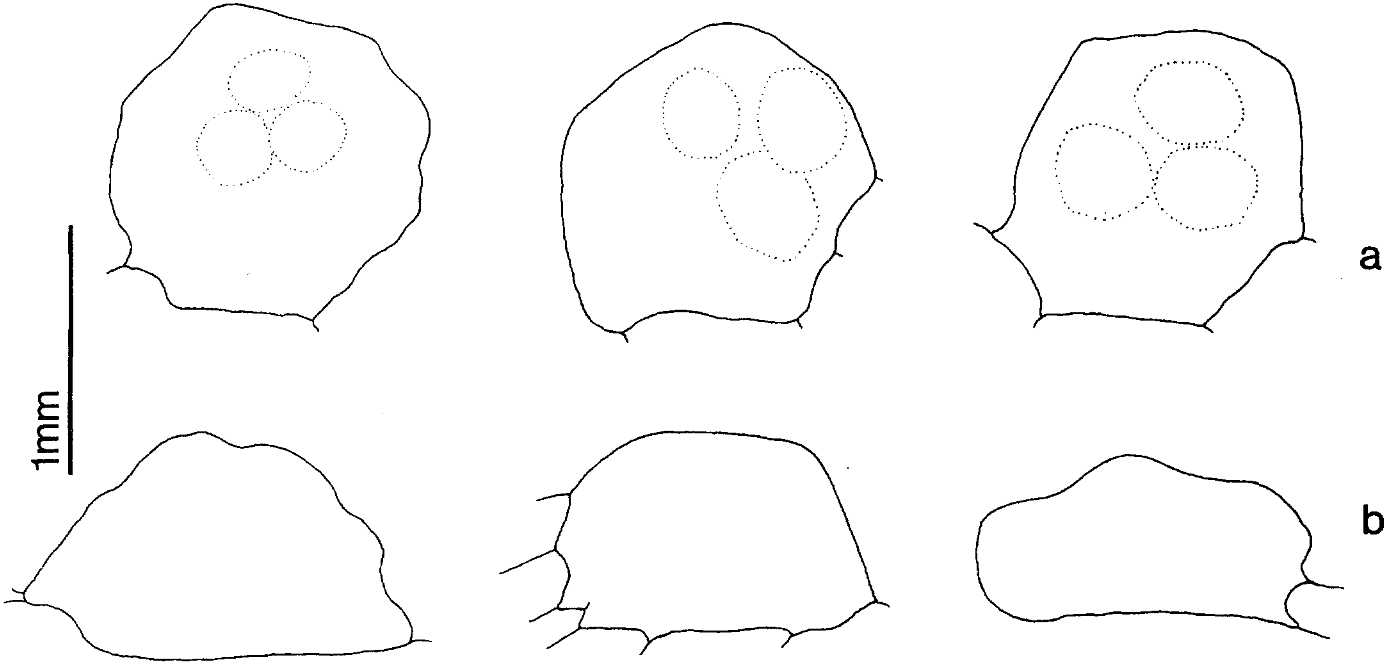

Fig. 2: Egg sac of *C. simonii*, variation; upper view (a), lateral view (b).

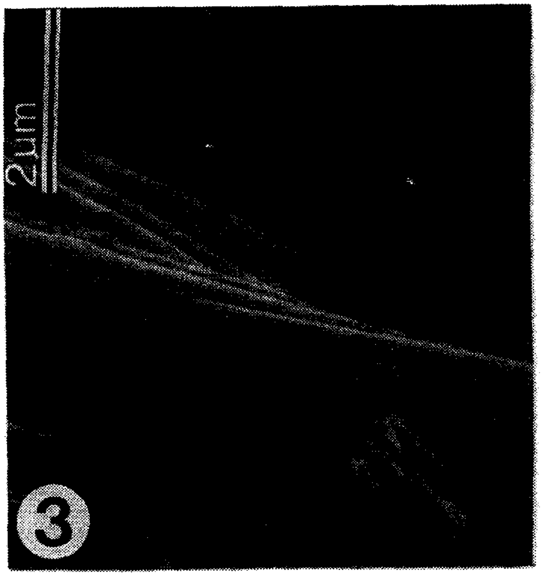

Fig. 3: Egg sac of *C. simonii*; silken coiled threads.

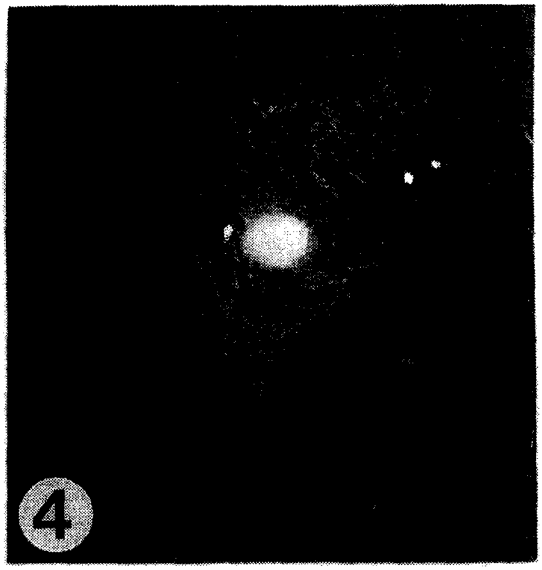

Fig. 4: Egg sac of *C. simonii* inside silken protective funnel.

Fig. 5: Egg sac of *C. simonii* after hatching of spiderlings.

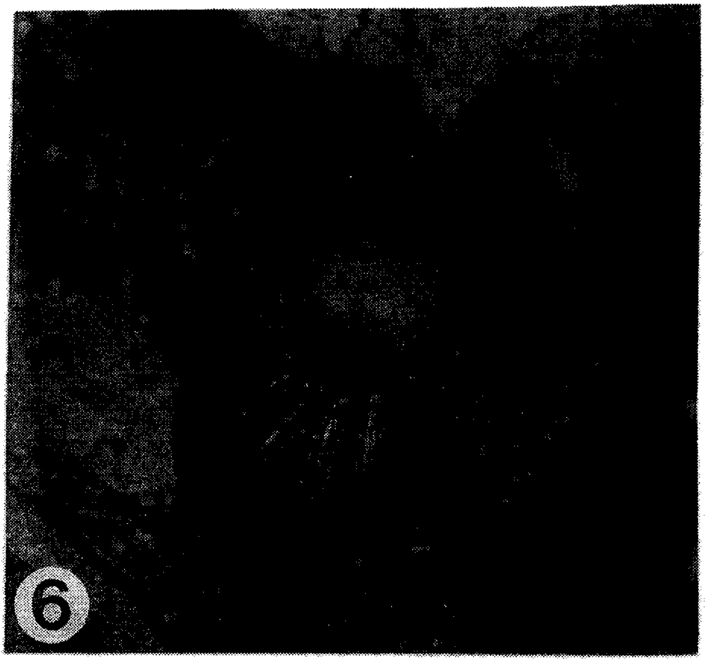

Fig. 6: Female of *C. simonii* remaining motionless after escape.

II. Spiderlings

Spiderlings developed only within one egg sac that had been built from 29th to 30th of June. They hatched after 27 days and remained inside the cocoon. The spiderlings performed slow movements with their walking legs, causing perforations of the egg sac (Fig. 5). One individual was clearly visible. It did not show any response to light, but reacted to mechanical disturbance when the egg sac was touched with a needle: The spiderling pulled the distal leg segments of the first pair of legs (weak stimulus) or of all pairs of legs (strong stimulus) jerkily to the body. The differentiation of these leg segments to patella, tibia, metatarsus, and tarsus was not clearly recognisable.

On the 28th day the first moulting probably took place. The spiderlings showed a translucent white colour and the legs appeared more differentiated. As a response to light and mechanical disturbance the animals showed co-ordinated walking movements inside the egg sac. On the 33rd day two spiderlings moulted a second time. The third individual died during this process. On the 35th day the two remaining animals left the cocoon by passing one of the many perforations of the cocoon wall. They immediately began to build webs, in a distance from the remnant of the egg sac of 1 and 3 cm respectively. The webs closely resembled those of the adults (Kropf 1990a), apart from showing approximately half the diameter of these. The position of the spiderlings inside the web was variable, as it is the case in adults. Furthermore they changed their webs several times and, like the adults, used their own web as well as that of the other individual. Obviously they were able to catch prey, since the globular remnant of a juvenile collembole was found inside one web. 14 days later both spiderlings had disappeared without having performed another moult.

III. Habitat preferences

Most specimens were found to inhabit deeper ground layers between the L- and the O-horizon during summer and autumn (Kropf 1990a); this area, where the decomposition layer borders on the litter layer (for nomenclature see Schaefer & Tischler 1983), is characterized by a rich fauna of Collembola (Schaller 1950) which probably are the main prey items (Kropf 1990a). A random sample in June showed 12 specimens (all data concern adults exclusively) in the L-horizon, 44 at the border between the two, and 4 in the O-horizon (Tab. 1).

During winter and early spring as well as after heavy rainfalls the leaf litter is very wet. In response to this *Comaroma* seems to avoid direct contact with wetness by moving upwards so that most individuals are found in the upper layers of the L-horizon: a random sample in December showed 7 specimens there, 3 at the border between the two and none in the O-horizon. Another sample in June, after heavy rainfalls had occurred the night before, showed 20 spiders in the L-horizon, 3 at the border between the two and 3 in the O-horizon (Tab. 1). These are only approximate values since sieving by hand makes the different layers difficult to define.

Tab. 1. Distribution of adult individuals of *C. simonii* in different litter layers.

	L-horizon	**border between L- and O-horizon**	**O-horizon**	**ratio**
'normal' conditions	12	44	4	0.2/0.73/0.07
winter	7	3	0	0.7/0.3
summer, after rain	20	3	3	0.77/0.11/0.11

During summer and autumn the leaf litter may dry out to a high degree. In this situation all individuals of *Comaroma* that were found occurred in high density in some humid soil depressions filled with fallen leaves. The spiders could not be found at all other sites where they normally occurred, not even in the deepest soil layers. Other hygrophilous arthropods were found in these soil depressions as well: *Aptilotus paradoxus* (Diptera, Sphaeroceridae), *Polyzonium germanicum* (Diplopoda, Polyzoniidae) and *Trachysphaera* sp. (Diplopoda, Trachysphaeridae).

IV. Phenology and sex ratio

Both sexes of *C. simonii* were collected in roughly constant numbers throughout the year. During winter fewer specimens were found; the reason for this probably was the wetness of the leaf litter that made sieving less efficient. All together 152 adult specimens were collected. The sex ratio was 98 females to 54 males.

V. Subadults and juveniles

Only eight subadult specimens were found, all in June, August, October and November: 25.6.1988, 1M, 1F. 29.6.1987, 1M. 17.8.1988, 1F. 4.10.1988, 1M. 7.10.1987, 2M. 17.11.1989, 1M. Subadults were recognized by their body form, eyes and typical formation of hairs on the carapace (Kropf unpubl.). Subadult males show enlarged palpal tarsi, so it is easy to recognise the sexes. Subadult specimens of *C. simonii* are of pale white or yellowish colour and do not show the sclerotization of the body that is typical for adults. Freshly moulted adults are pale as well and show thin scuta that are hardly visible. In addition, four juvenile spiders were found that showed the eye pattern typical for *Comaroma*. Juveniles and subadults were always found together with adults. As the species determination of juveniles must remain doubtful, no further data are given.

One subadult male was kept in the laboratory for three months (beginning of October to beginning of January). It built webs identical to those of adults (Kropf 1990a) and died shortly before its final moult.

VI. Life span

Adult spiders, that were collected in the natural habitat, survived in the laboratory for 2-3 months on the average. Several females survived for more than one year, one for 521 days (15 °C, dim light). For one winter (January to April) this female was kept at a temperature of 2 °C. The oldest male died after 108 days.

VII. Response to disturbances

As a response to disturbance by light or mechanical stimulation *C. simonii* escapes rapidly. As in normal walking it produces a security thread. While escaping it may pass a distance of more than 10 cm. In most cases the spider hides finally, for example under a piece of leaf. In this position all legs are pulled towards the body (Fig. 6) and the animal remains motionless for up to 5.5 minutes. This 'escape and hide' behaviour was observed in one subadult spider as well. A second stimulation of the resting spider results in another escape, even exhausted specimens tried to escape once more. So, this behaviour does not correspond to a thanatosis.

VIII. Phoretic mites

In December, two adults were collected, that carried phoretic mites of the family Anoetidae. In one case the mite was attached to the anterior prosoma, laterally behind the eyes. In the second case it was near the middle of the prolateral-dorsal side of femur IV.

DISCUSSION

I. Egg sac

Some Anapidae place their egg sacs just above the hub of their orb web (Coddington 1986; Eberhard 1987). This character was regarded as a synapomorphy uniting Mysmenidae and Anapidae by Coddington (1986). However, Hickman (1938) figured the egg sac of *Risdonius parvus* Hickman, 1938 attached to a piece of leaf or wood, but not to a web thread. Furthermore, he (1943) remarked that the egg sac of *Hickmanapis minuta* (Hickman, 1943) was attached to a piece of moss. Egg sacs being attached above the hub of an orb web were reported only for the genera *Anapis* and *Anapisona* (Platnick & Shadab 1978; Coddington 1986; Eberhard 1987). The results presented here show too, that this trait is variable within the family Anapidae so that its taxonomic significance should be re-evaluated.

The protecting funnel of the egg sac of *C. simonii* is unique among Anapidae, as far as it is known. Within Theridiidae, *Theridion melanurum* Hahn, 1831 and related species build a similar web protecting the egg sac (Wiehle 1937, 1952; Nielsen 1932). However, as previously discussed

(Kropf 1990b), *Comaroma* most probably does not belong to the Theridiidae; thus, the webs protecting the egg sacs in certain *Theridion*- and *Comaroma*-species must have evolved convergently.

Few data exist about the number of eggs per egg sac in Anapidae; it varies between two and ten (Hickman 1938, 1943; Platnick & Shadab 1978). It seems that the eggs of *Comaroma* are well protected by the silken funnel described above; this could explain the low number of eggs.

II. Spiderlings and subadults

Data on anapid spiderlings are extremely fragmentary. Hickman (1938) reported for *Risdonius parvus*, that the spiderling hatched 19-33 days after the egg sac was laid; 10-12 days after hatching they left the egg sac. In *Hickmanapis minuta* spiderlings left the egg sac 30 days after the egg sac was laid (Hickman 1943). These data are similar to the results presented here for *Comaroma*, where spiderlings hatched on the 27th day after egg sac laying and emerged on the 35th day. Information on webs of anapid spiderlings are presented here for the first time.

Subadults of *Comaroma* were found between June and November - these data indicate the absence of a strictly limited reproductive period. Moreover the data give evidence, that the sclerotization of the body, that is typical for adult spiders of the family Anapidae, is developed after the final moult. The fact that both juveniles and subadults were found extremely rarely may indicate that these developmental stages are short-lived or occur also in other habitats.

The ratio between subadults and adults presented here is misleading, as all available subadult spiders were collected, but not all available adults.

III. Habitat preference

C. simonii shows specialized habitat preferences. Normally, it inhabits deep layers of leaf litter in humid deciduous forests, one finding was in a cave in Switzerland (Thaler 1978). Among spiders (e.g. Tretzel 1952; Polenec 1966, 1969a; Thaler 1968) and opilionids (e.g. Kraus 1961) many species are known to inhabit both caves and deep ground layers. Because of this Polenec (1969b, 1970) felt that cavernicolous species might have migrated into the caves from deep layers of fallen leaves outside. Moreover he showed that in microcavernicolous spiders (that inhabit small caves and canals dug by small mammals) parts of the life cycle take place close to the surface of the litter (Polenec 1973, 1975, 1979).

In *Comaroma* (which at best occasionally lives in microcaverns) the situation is similar. As it seems to avoid direct contact with wetness, it is usually found in the upper litter layers after heavy rains and in winter. This means that it occasionally performs vertical migrations. During dry periods it is found only at some humid soil depressions in high numbers, which allows the conclusion that horizontal migrations had occurred. Thus, the 'habitat' of

C. simonii is not restricted to a limited location but is represented by dynamic interactions of different ecological factors. An optimal degree of humidity seems to play a major role, as was supposed by Kropf (1993).

Moreover, the specialized habitat preferences of *C. simonii* may help to understand some of the peculiarities of this species. For example, it is plausible to assume that the remarkable eye reduction, mainly of the anterior median eyes (Baert & Kekenbosch 1980; Schuster & Moschitz 1984), can be seen as an adaptation to dim light (or even darkness), that is characteristic for the habitat of *Comaroma*. The same pronounced reduction of the AME was reported for *Cybaeus yoshiakii* Yaginuma, 1968 (Cybaeidae), that 'lives under dead leaves' (Yaginuma 1968: 33). For species of other families of spiders similar assumptions were made, e.g. by Denis (1939) and Kaston (1962). The phenomenon of AME reduction is common in many cavernicolous and detriticolous spiders of different taxa (Brignoli 1970).

The peculiar web of *C. simonii* can be regarded as a strongly modified anapid orb web (Kropf 1990a), since a 'normal' orb web would be dysfunctional in deep leaf layers. Similar webs are built by *Zangherella*-species (Kratochvil 1935) that inhabit caves, litter and humus (e.g. Kratochvil 1935; Brignoli 1968, 1971, 1974, 1978; Caporiacco 1949).

The inhabitation of a living space with rather constant conditions, the apparent low reproductive rate, the brood care by producing a protective web for the egg sac and the long life span suggest that *C. simonii* is a 'k-strategist' or a 'k-selected' species, respectively (Begon *et al.* 1990).

IV. Phenology

Collecting by hand has the disadvantage, that the results depend on the activity of the collector. Furthermore, *C. simonii* was collected according to requirement of specimens for morphological and biological studies, apart from voucher specimens, of course. For this reason the presented data only allow the conclusion, that adults of both sexes occur throughout the year in roughly constant numbers, but a statistical proof of the phenological data cannot be presented.

Nevertheless, the data allow the conclusion that *C. simonii* can be termed as an eurychronous species of type I according to Schaefer (1976) or as an eurychronous species of the *Porrhomma egeria* - type according to Tretzel (1954). In these spiders, mostly troglo- or oikobiontic species, the periodicity of the reproductive period had been lost to a high degree. They live under roughly constant microclimatic conditions (Tretzel 1954). Such conditions probably occur both in caves and deep layers of fallen leaves. The temporal distribution of both sexes of adults and subadults of *C. simonii* and the specific habitat preferences support this assessment.

V. Life span

The total life span of *C. simonii* is not yet known, but it turns out to be much longer than expected. It is difficult to decide whether a long life span should be regarded as primitive or derived in general (cf. Gerhardt 1924; Tretzel 1954); probably both possibilities are realized within the Araneae.

VI. 'Escape and hide' behaviour

Braun (1965) refers to thanatosis as an imitation of a dead animal that cannot be removed even by strong stimuli. Such a behaviour could not be observed in *C. simonii*. But it should be mentioned that Schuster and Moschitz (1984) reported a thanatosis for this species. Orb web building anapids escape from their webs by dropping (Hickman 1943). *Zangherella* escapes by dropping without spinning a thread and pulling the legs towards its body (Kratochvil 1935).

Acknowledgements

For multiple help and advice on scientific matters I am grateful to Prof. Dr. R. Schuster, my supervisor during the time I investigated *Comaroma* at the Zoological Institute, Karl-Franzens-University of Graz, Austria. For valuable information I am indebted to UD Dr. K. Thaler, Innsbruck, Austria, and to Dr. P. Horak, Graz. For the identification of a phoretic mite I thank UD Dr. E. Ebermann, Graz.

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