STUDIES ON PARASITISM, DEVELOPMENT AND PHENOLOGY OF *JOHNSTONIANA PARVA* N. SP. (ACARI : PARASITENGONAE : JOHNSTONIANIDAE) INCLUDING A DESCRIPTION OF ALL ACTIVE INSTARS.

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TROMBIDIOIDEA
NEW SPECIES
LIFE CYCLE
PARASITISM
PHENOLOGY
HABITAT RESTRICTION

SUMMARY : In controlled experiments, all ontogenetic instars of *Johnstoniana parva* n. sp., a relatively small member of the genus, were reared. The species is described morphologically for all active instars (adult, deutonymph, larva). All stages appear to be restricted to wet places and live more or less concealed within the humid litter layer. *J. parva* is an univoltine species, but it is suggested that there are two oviposition periods : (1) After insemination in autumn, these eggs hibernate, diapausing within the substratum. (2) After hibernation in late spring, by females which have also been inseminated in autumn of the year before. Adults die soon after reproduction ; males do not survive the winter. The larva emerges from June to August and is parasitic on parasitengonid mites, with a preference for those of other species of the same genus. After passing through the parasitic phase, individuals develop quite quickly to the adult instar within the same year. The active postlarval instars prey on diptera larvae and pupae. The data on parasitism and phenology is discussed with regard to habitat restriction of this species.

TROMBIDIOIDEA
NEUE ART
LEBENS-ZYKLUS
PARASITISMUS
PHÄNOLOGIE
HABITATBINDUNG

ZUSAMMENFASSUNG : Unter kontrollierten Versuchsbedingungen gelang es, alle Ontogenesestadien von *Johnstoniana parva* n. sp. zu züchten. Die Art ist im Vergleich zu anderen Arten der Gattung *Johnstoniana* relativ klein. Alle aktiven Stadien (Adultus, Deutonymphe, Larve) werden morphologisch beschrieben. *J. parva* scheint strikt an nasse Lebensräume gebunden zu sein und lebt dort mehr oder weniger verborgen innerhalb der Streuschicht. Die Art ist univoltin, hat jedoch möglicherweise alternativ zwei Phasen der Eiablage : (1) Im Herbst nach der Befruchtung. Diese Eier überwintern in Diapause innerhalb des Ablagesubstrates. (2) Im späten Frühling nach Überwinterung von Weibchen, die aber bereits ebenfalls im Herbst des vorhergehenden Jahres befruchtet wurden. Erwachsene Tiere sterben kurz nach der Fortpflanzung, Männchen überleben den Winter nicht. Die Larve tritt von Juni bis August auf. Sie parasitiert andere parasitengone Milben, vorzugsweise jedoch Arten der gleichen Gattung. Nach Durchlaufen der parasitischen Phase entwickeln sich die Individuen schnell bis zum Adultus noch innerhalb desselben Jahres. Larven und Puppen von Dipteren bilden die Nahrung der postlarvalen aktiven Stadien. Die Daten aus den Untersuchungen zu Parasitismus und Phänologie werden hinsichtlich der Habitatbindung dieser Art diskutiert.

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TROMBIDIOIDEA
NOUVELLE ESPÈCE
STADES DU DÉVELOPPEMENT
PARASITISME
PHÉNOLOGIE
HABITAT RESTREINT

RÉSUMÉ : Au cours d'expériences contrôlées, tous les stades de l'ontogenèse de *Johnstoniana parva*, un représentant relativement petit du genre, ont été élevés. La morphologie de cette espèce est décrite pour tous les stades actifs (adulte, deutonymphe, larve). Tous les stades paraissent se maintenir restrictivement dans les lieux humides et vivre plus ou moins cachés dans la couche humide de la litière. *J. parva* est une espèce univoltine, mais il est suggéré l'existence de deux périodes d'oviposition : 1) Après l'insémination à l'automne ; les œufs hibernent en entrant en diapause au sein du substratum. 2) Après l'hibernation à la fin du printemps par des femelles qui ont été aussi inséminées à l'automne de l'année précédente. Les adultes meurent aussitôt après la reproduction ; les mâles ne survivent pas à l'hiver. La larve émerge de juin à août et est parasite d'un parasitengonide, avec une préférence pour les espèces du même genre. Après avoir franchi la phase parasitaire, les individus se développent tout à fait rapidement en adulte au cours de la même année. Les stades postlarvaires actifs se nourrissent de pupes et de larves de diptères. Le parasitisme et la phénologie de cette espèce sont discutés en fonction de son habitat restreint.

INTRODUCTION

Although the phylogenetic relationship of the Johnstonianinae within the Trombidioidea is still a subject of dispute, this subfamily, nevertheless, is widely accepted as being an early derivated group within the Trombidioidea s.l. (NEWELL, 1957, ROBAUX, 1973, KRANTZ, 1978, WELBOURN, 1984, 1991, SOUTHCOTT, 1987, WITTE, 1984, 1991 and others).

In Europe, five species of the genus *Johnstoniana* George 1909 are known (COOREMANN, 1949, SCHWEIZER, 1951, FEIDER, 1955, 1958a, 1958b, ROBAUX, 1970). Unfortunately, in the case of two of these species (*J. harghitense* Feider, *J. ventripilosa* Feider), only the larval stage is known (FEIDER, 1958b). *J. maxima* Feider was described from the adult, deutonymphal and larval instars, albeit without reliance on laboratory correlation (FEIDER, 1955, 1958a). For *J. errans* (Johnston), ROBAUX (1970), under controlled rearing conditions, established the correlation between the larval and the adult instars. WOHLTMANN et al. (in press) recently redescribed *J. tuberculata* Schweizer ; namely the parasitic larva, predatory deutonymph and adult as being the typical active instars of the Parasitengonae. Apart from special morphological and biological characteristics, *J. tuberculata* differs from the other *Johnstoniana* species by its comparatively small size.

For various reasons, the present knowledge of species of *Johnstoniana* is only scant, though it must be said that this generally applies for the Johnstonianidae as well. The difficulties encountered in obtaining more precise information are probably due to (1) concealed habits and (2) restricted seasonal occurrence of the respective active instars. Only COOREMANN (1949) and ROBAUX (1970) found large numbers of postlarval instars in the field. With the exception of *J. tuberculata*, data in the literature concerning the life cycle refer only to the larvae. Typically, they seem to parasitize imagos of tipulids (COOREMANN, 1949, FEIDER, 1955b, NEWELL, 1957, RACK, 1976, WOHLTMANN et al., in press). The occurrence of *Johnstoniana* species seems to be restricted to very humid biotopes (NEWELL, 1957) i.e. in close proximity to running or stagnant, limnic waters.

In the present paper, the successful rearing of *Johnstoniana parva* n. sp., another relatively small species of this genus, from the egg to the adult instar under controlled conditions, will be documented. Apart from making the morphological description of all active instars possible, it also yields a fund of basic biological data obtained both in the laboratory and the field, which, in our opinion, is indispensable for modern taxonomical investigations. Some of this data was obtained during the course of investigations on parasitism and development of *Johnstoniana* sp. (EGGERS, in press), ecophysiological investigations of *Johnstoniana* spp. (WENDT, in press) and studies on life

cycle strategies of several terrestrial Parasitengonae (WOHLTMANN, in prep.).

MATERIAL AND METHODS

Individuals of *Johnstoniana parva* n. sp. were captured by hand from 1989 to 1992 in the litter layer of the reed-belt, close to the shore of lake " Wittensee " in Northern Germany (Fig. 1 a). During this period in summer and autumn, the area of investigation was characterized by a high relative air-humidity of 100 % and a perpetually wet substratum, whereas during winter and early spring it was submerged for several months (Fig. 1 b).

General rearing of all ontogenetic instars was carried out in plastercharcoal-filled polystyrene boxes (25 × 25 × 20 mm). Saturated air humidity was achieved by the addition of appropriate amounts of water to the substratum. All active postlarval instars and the hosts of *J. parva* were fed mainly on *Drosophila melanogaster* larvae but sometimes also on ant eggs and larvae. Eggs of single females were separated, mixed and subjected to different rearing conditions in order to obviate the effects of any possible errors arising from the presence of non inseminated females. The ontogenetic instars of *J. parva* were reared as follows :

(1) 80 eggs deposited in October 1990, exposed to a constant 15 ° C and 12h/12h light/dark photoperiod.

(2) 10 eggs deposited in October 1991 exposed to a constant 15 ° C and the following, successive photoperiods : 73 days 6h/18h L/D ; then 10h/14h L/D.

(3) 20 eggs deposited October 1991, exposed to the following, successive regimes : 53 days at 15 ° C and 6h/18h L/D ; 46 days at 15 ° C and 10h/14h L/D ; 127 days at 4 ° C and darkness ; 20 ° C and darkness.

(4) 59 larvae captured in the field, attached parasitically to their hosts.

(5) 10 larvae from rearing experiment (3) were put together with 5 deutonymphs of *J. tuberculata*. Similar attempts were made with adult *Allothrombium fuliginosum* (Hermann), *Platytrombidium sylvaticum* (C.L. Koch) and deutonymphal *J. parva* and *Calyptostoma velutinus* (Müller).

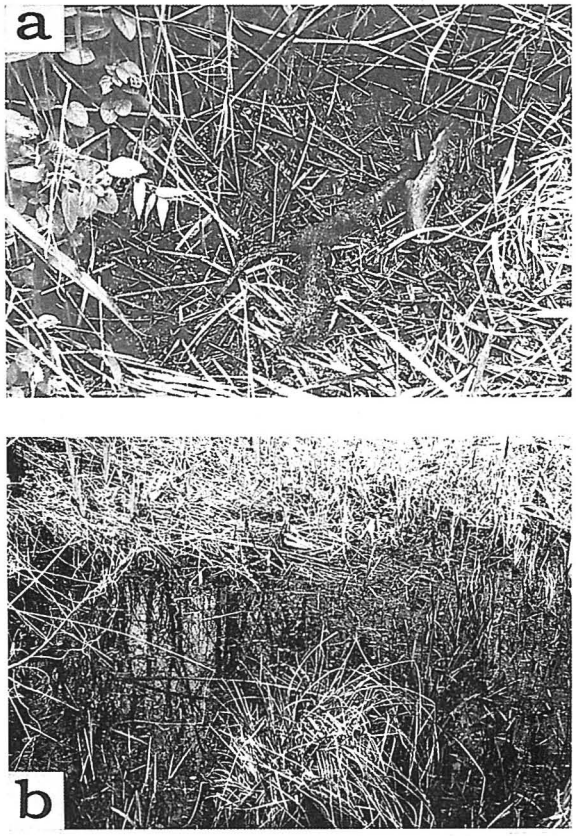

FIG. 1 : *Johnstoniana parva* n. sp., locus typicus : reed belt of lake " Wittensee ". a. — 27.06.90. b. — 08.04.92.

Furthermore, experiments on parasitism were carried out using the following dipterans : imagos of *Limonia* sp. ; larvae, pupae and imagos of various Tipulidae and of *Drosophila melanogaster* ; and larval Chironomidae. The duration of each experiment was at least 4 days.

All rearing experiments were checked daily.

The specimens used for taxonomic descriptions were : (1) laboratory-reared adults and deutonymphs from parasitic larvae (captured on their hosts at lake " Wittensee " 03.07.90) and (2) larvae reared from eggs deposited by females, captured 22.08.90. For control purposes, larvae and adults from the field were investigated in the same way. Descriptions and measurements were obtained

from permanent mounts of specimens cleared with lactate and embedded in polyvinyl-lactophenol or Hoyer's medium. Drawings were made using a microscope (BH-2, Olympus, Japan) with interference phase contrast and a camera lucida. The terminology and measurements follow SOUTHCOTT (1961).

Johnstoniana parva n. sp.

(Figs. 2, 3)

FEMALE

Idiosoma : Length 1123-1669 µm, mean= 1435 µm (n= 4), width 811-1139 µm, mean= 1006 µm (n= 4) ; subrectangular in non-ovigerous individuals. Colour when alive-reddish.

Dorsum : Propodosoma with a single scutum (Fig. 2 a) and two pairs of eyes, located laterally on protruding, bicorneate ocular plates. Anterior lens larger (44 µm) than posterior (28 µm). Scutum forms a strongly sclerotized crista metopica along its median axis ; with two pairs of smooth trichobothria. Crista metopica anteriorly forms an area sensilligera around anterior trichobothria, widening midway into a thickend part and posteriorly merging into the posterior margin of the scutum. 2-5 (n= 4) slightly serrated scoboscutalae are inserted on each side of the thickened part of the plate. Behind the posterior trichobothria, an additional pair of scoboscutalae is located on the scutum, half way between the level of the posterior trichobothria and lateral margins of scutum. Measurements of scutum are given in Tab. 1. Hysterosoma covered with numerous smooth, rigid setae (40-55 µm in length), inserted near the anterior margins of ovoid sclerites (16-19 µm long, Fig. 2 b, c).

Venter : Ventral part of hysterosoma covered with numerous more slender, smooth idiosomalae (43-57 µm length) inserted near the anterior margins of ovoid plates (12-14 µm long). Genital opening with two well sclerotized genital valves on each side (inner valves 256-282 µm in length, outer valves 272-294 µm) and three genital acetabula. Inner genital valves with 13-18 setae each, outer genital valves with 22-25 setae each ; all setae similar to ventral idiosomalae. Anal opening posterior to genital orifice. Coxae I/II close together, as are coxae III/IV. Coxal plates porous, with numerous smooth coxalae similar to ventral idiosomalae.

	Larva n=7	Deutonymph n=1	Adult n=11
LENGTH	118 (113-125)	250 (/)	351 (289-415)
WIDTH	123 (113-137)	204 (/)	316 (289-352)
SBA	11 (10-13)	16 (/)	22 (19-25)
SBP	38 (35-47)	59 (/)	84 (66-94)
ISD	39 (37-42)	68 (/)	93 (75-106)
ASBA	35 (24-40)	72 (/)	96 (63-126)
ASENS	57 (54-62)	61 (/)	87 (84-91)
PSENS	129 (121-144)	damaged	185 (163-207)
AW	71 (66-84)		
PW	111 (105-122)		
A-P	32 (25-36)		
AL	48 (41-51)		
PL	71 (62-86)		

TAB. 1 : *Johnstoniana parva* n. sp. : standard data (means) of the scutum of the respective instars. All lengths in µm, numbers in brackets : range. Abbreviations : n = number of specimens investigated, all others according to SOUTHCOTT (1961).

Gnathosoma : Palp tarsus as illustrated for male in Fig. 2 d. Distally with 6 solenoidalae and posteriorly with 1 solenoidala (n= 11).

Legs : segmental formula 7, 7, 7 (including coxae) ; measurements are given in Tab. 2. Apart from numerous solenoidalae and normal setae, tarsus I (Fig. 2 e) with 5-9 (n= 7) club-shaped solenoidalae and tarsus II with one club-shaped solenoidala and one vestigiala. Genu I and II each with 1 vestigial seta. Tarsi bear two simple, falciform, single claws.

MALE

Similar to female described above. Size of idiosoma somewhat smaller : in length 1202-1249 µm, mean= 1226 µm, in width 843-859 µm, mean = 851 µm. Differences in leg measurements are shown in Tab. 2. Palp tarsus (Fig. 2 d), vestigiala and club-shaped solenoidala on tarsus II as

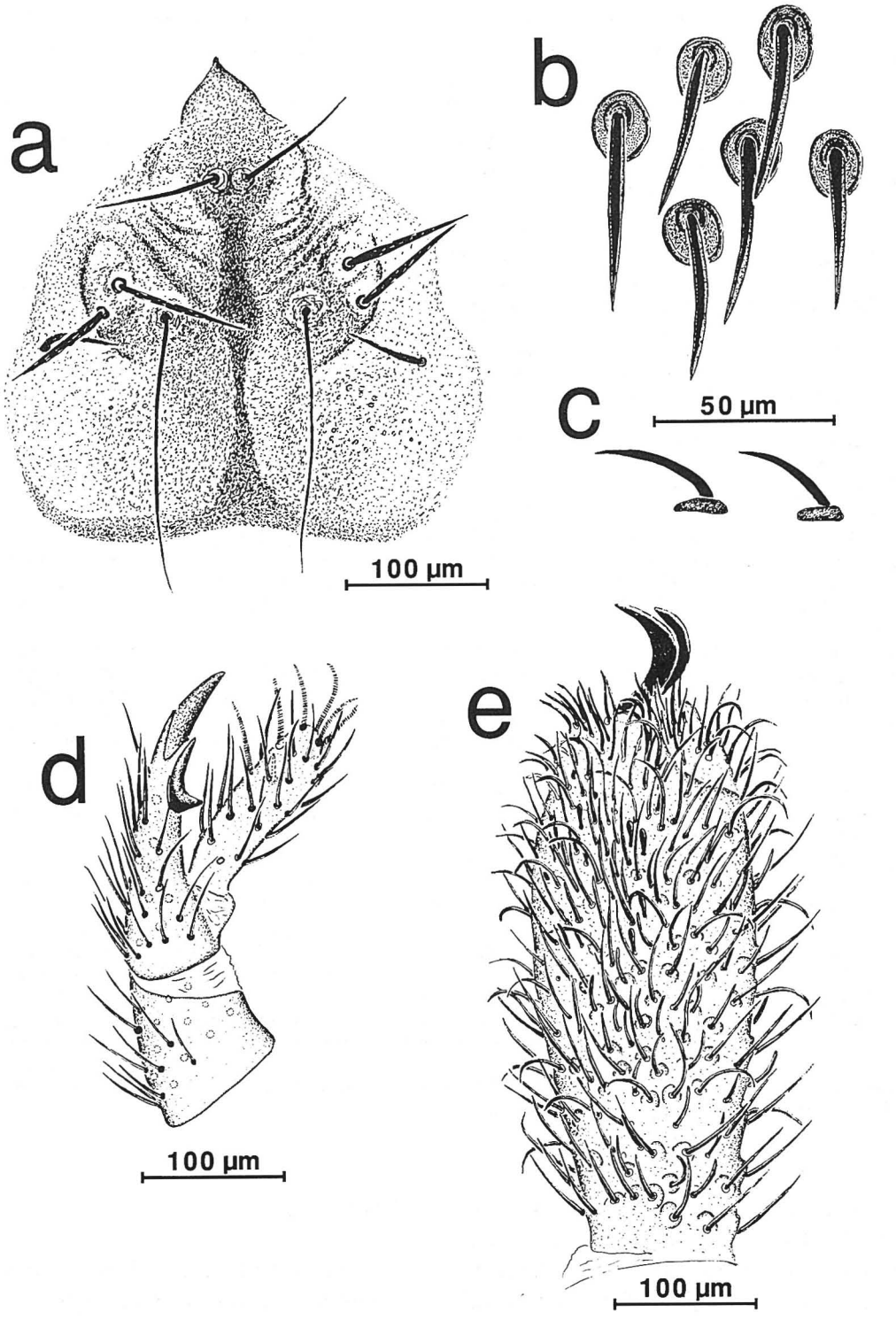

FIG. 2 : *Johnstoniana parva* n. sp., adult.

a. — Dorsal scutum. b. — Idiosomalae, viewed dorsally. c. — Idiosomalae, viewed in profile. d. — Tibia and tarsus of palp. e. — Tarsus I, viewed posteriorly. All figures from female, except 2 d.

	Larva N = 7	Deutonymph N = 2	Female N = 4	Male N = 3
PALP				
Genu	40 (34-42)	78 (75-82)	132 (119-145)	115 (107-126)
Tibia	39 (38-41)	137 (132-145)	208 (195-220)	179 (176-189)
Tarsus	37 (34-41)	97 (94-101)	154 (145-165)	130 (119-138)
Leg I				
Coxa	102 (97-108)	170 (157-176)	240 (226-258)	215 (201-233)
Trochanter	38 (36-40)	86 (82-88)	140 (132-151)	149 (126-176)
Basifemur	70 (58-73)	170 (164-176)	269 (252-289)	220 (195-233)
Telofemur	47 (42-50)	140 (138-145)	233 (233-233)	203 (195-208)
Genu	65 (60-68)	174 (170-182)	273 (264-283)	246 (239-252)
Tibia	78 (68-82)	198 (189-208)	308 (302-314)	280 (264-289)
Tarsus	139 (123-144)	249 (239-252)	384 (377-390)	343 (321-358)
Total length	538 (498-552)	1187 (1152-1220)	1848 (1818-1886)	1657 (1604-1724)
LEG II				
Coxa	89 (85-97)	176 (170-189)	252 (239-264)	217 (208-239)
Trochanter	36 (36-37)	75 (69-82)	132 (113-157)	135 (126-145)
Basifemur	65 (53-69)	132 (132-132)	201 (189-220)	165 (151-182)
Telofemur	36 (31-39)	100 (94-107)	161 (145-170)	141 (132-145)
Genu	50 (47-53)	108 (107-113)	179 (170-182)	157 (151-164)
Tibia	63 (53-68)	124 (119-126)	203 (201-208)	185 (182-189)
Tarsus	107 (86-115)	189 (189-189)	293 (252-308)	261 (252-264)
Total length	446 (395-466)	906 (887-925)	1421 (1390-1460)	1261 (1220-1290)
LEG III				
Coxa	95 (89-102)	176 (170-182)	277 (258-289)	239 (226-252)
Trochanter	48 (45-55)	97 (88-107)	158 (145-176)	148 (138-164)
Basifemur	75 (63-69)	138 (132-151)	211 (189-239)	176 (157-195)
Telofemur	49 (45-52)	113 (107-119)	186 (182-195)	162 (151-176)
Genu	66 (60-71)	133 (126-138)	212 (208-220)	189 (189-189)
Tibia	86 (71-95)	153 (138-164)	269 (252-283)	239 (233-252)
Tarsus	135 (116-144)	218 (214-226)	372 (346-390)	319 (308-346)
Total length	554 (492-588)	1029 (1013-1050)	1685 (1648-1737)	1473 (1441-1510)
LEG IV				
Coxa		196 (189-201)	312 (302-327)	269 (258-289)
Trochanter		157 (151-164)	264 (245-277)	225 (214-239)
Basifemur		174 (170-182)	298 (283-314)	255 (245-264)
Telofemur		165 (157-176)	296 (283-302)	263 (245-270)
Genu		209 (201-220)	340 (327-352)	305 (289-321)
Tibia		278 (264-289)	440 (428-465)	400 (377-415)
Tarsus		284 (283-289)	459 (440-478)	414 (377-440)
Total length		1465 (1440-1503)	2410 (2377-2484)	2130 (2018-2188)

TAB. 2 : *Johnstoniana parva* n. sp. : leg dimensions (means) of the respective ontogenetical instars. All lengths in µm, numbers in brackets : range. Abbreviation : n = number of specimen investigated.

in female, tarsus I with 6-7 club-shaped solenoidalae (n= 2). Genu I and II each with 1 vestigial seta. Inner genital valves 200-220 µm (12-16 setae each), outer 240-285 µm (25-30 setae each) (n= 3) in length. Sclerotized ejaculatory complex of genital system visible inside body of cleared specimens.

DEUTONYMPH

In general like adult, though somewhat smaller. Idiosoma 786 µm in length and 566 µm in width (n= 1). Measurements of scutum and legs are given in Tab. 1, 2. Apart from numerous solenoidalae and normal setae, tarsus I with 4-5 (n= 2) club

-shaped solenoidalae and tarsus II with one club -shaped solenoidala and one vestigiala. Genu I and II each with 1 vestigial seta. Palp tarsus distally with 4 and posteriorly with 1 solenoidala. Genital opening with only one genital valve (130 µm in length, 7 setae each, n= 1) and two genital acetabula on each side.

Larva

Idiosoma : Length 283-333 µm, mean 315 µm, width 245-270 µm, mean 255 µm (n= 6). Colour when alive-light red.

Dorsum (Fig. 3) : Propodosoma with a single scutum and laterally with a pair of non-protruding, bicorneate eyes on either side. Lenses almost circular, the anterior larger (17 µm) than the posterior (11 µm). Scutum covered with small pores, triangular with rounded angles and a projecting naso anteriorly. Two pairs of trichobothria. Along its median axis a crista metopica anteriorly forming an area sensilligera bearing the anterior trichobothria. Crista in the half of its length widened to a thickened plate, bearing the posterior trichobothria. Anterior trichobothria weakly setulate distally, posterior trichobothria smooth. Two pairs of setulose scoboscutalae. Measurements of scutum are given in Tab. 1.

Hysterosoma with approximately 22 idiosomalae, inserted on distinct plates (22 µm in diameter). Idiosomalae (65-120 µm in length) curved posteriad, with setules on the distal part ; concave side of idiosomalae smooth.

Venter (Fig. 4 a) : Hysterosoma with approximately 23 idiosomalae posterior to coxae III and a further pair at level of coxae III. All idiosomalae (35-50 µm in length) slightly serrated, inserted on distinct plates (12 µm in diameter). Urstigmata between coxae I and II at the lateral margins of body. Anal opening median, posterior to coxae III. Coxa I and II moderately separated. Coxalae : 2,1,1 ; all coxalae very slightly serrated (oil immersion), lateral coxala I 67 µm, median coxala I and coxala III both 55-60 µm, coxala II 51 µm in length. Coxala II sometimes diverges at approximately half of its length (two tips).

Gnathosoma : Palp femur and genu each with 1 seta, palp tibia with 3 setae and a pair of strong claws, nearly rectangularly curved halfway along their length. Palp tarsus (Fig. 4 b, c) variable, the following cases being observed : 2 normal setae / 4 big featherlike setae / 1 solenoidala (N= 1), 3/3/1 (N= 5), 3/4/1 (N= 2), 4/3/1 (N= 1). Chelicera (Fig. 4 d) raptorial, movable digit falciform, blade with two teeth. Two pairs of hypostomalae ; the anterior smooth, 35-37 µm long, the posterior smooth or very slightly serrated, 51-56 µm in length.

Legs : segmental formula 7,7,7 (including coxae) ; measurements and chaetotaxy are given in Tabs. 2, 3. All tarsi bear two simple, falciform claws (Figs. 4 e, f).

Type series : Holotype female, reared from larva. Data for larva : parasitizing *Johnstoniana* sp. A, adult , lake " Wittensee ", Germany, 03.07.90, Wendt and Wohltmann collectors. Paratypes : 2 females, 1 male, 1 deutonymph, data as for holotype. 2 males, lake " Wittensee ", 25.10.90, Wendt collector. 5 larvae, reared from eggs. Data for females : lake " Wittensee ", 22.08.90, Wendt and Wohltmann collectors. 1 larva, parasitizing on *J.* sp. A (female), lake " Wittensee ", 21.07.89, Wendt collector. 1 larva, reared from egg. Data for female : lake " Wittensee ", 06.06.90, Wendt collector. Holotype and paratypes (1 male, 1 deutonymph, 2 larvae) in " Rijksmuseum van Natuurlijke Historie ", Leiden, The Netherlands. Other paratypes in the " Acarology Laboratory Collection, Museum of Biological Diversity ", Columbus (OH), USA (1 female, 1 male, 1 larva), in the " Australian National Insect Collection ", Canberra, Australia (1 female, 1 male, 1 larva), in " Naturhistorisches Museum Basel ", Basel, Switzerland (1 larva) and in the authors collection.

Phenology

In the field, the larvae of *Johnstoniana parva* were found parasitically attached to their hosts for the period 1989 to 1992, from early June to late August. Each year, parasitic larvae could be found over this comparatively long period, with the

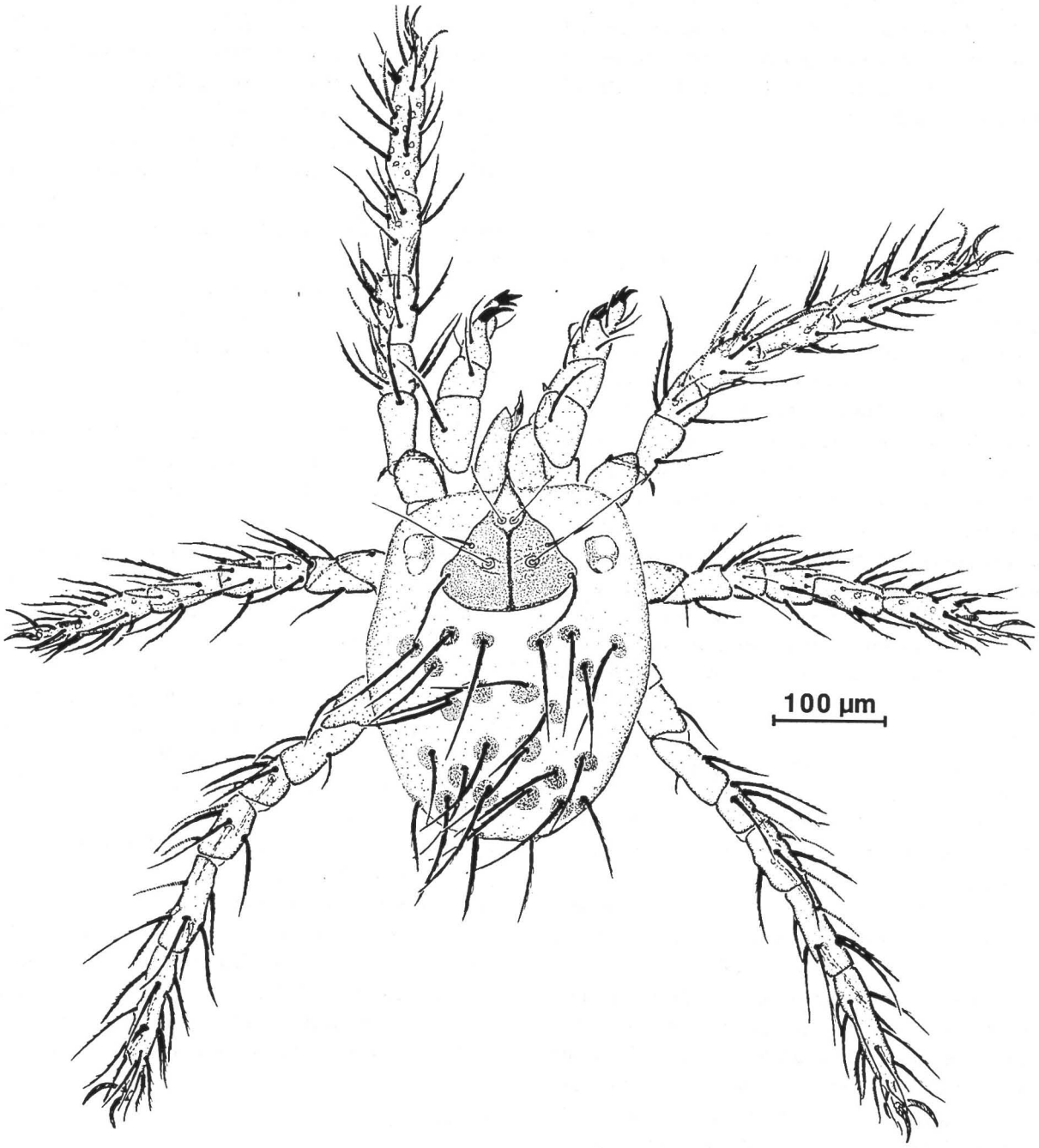

FIG. 3 : *Johnstoniana parva* n. sp., larva : habitus, dorsal aspect.

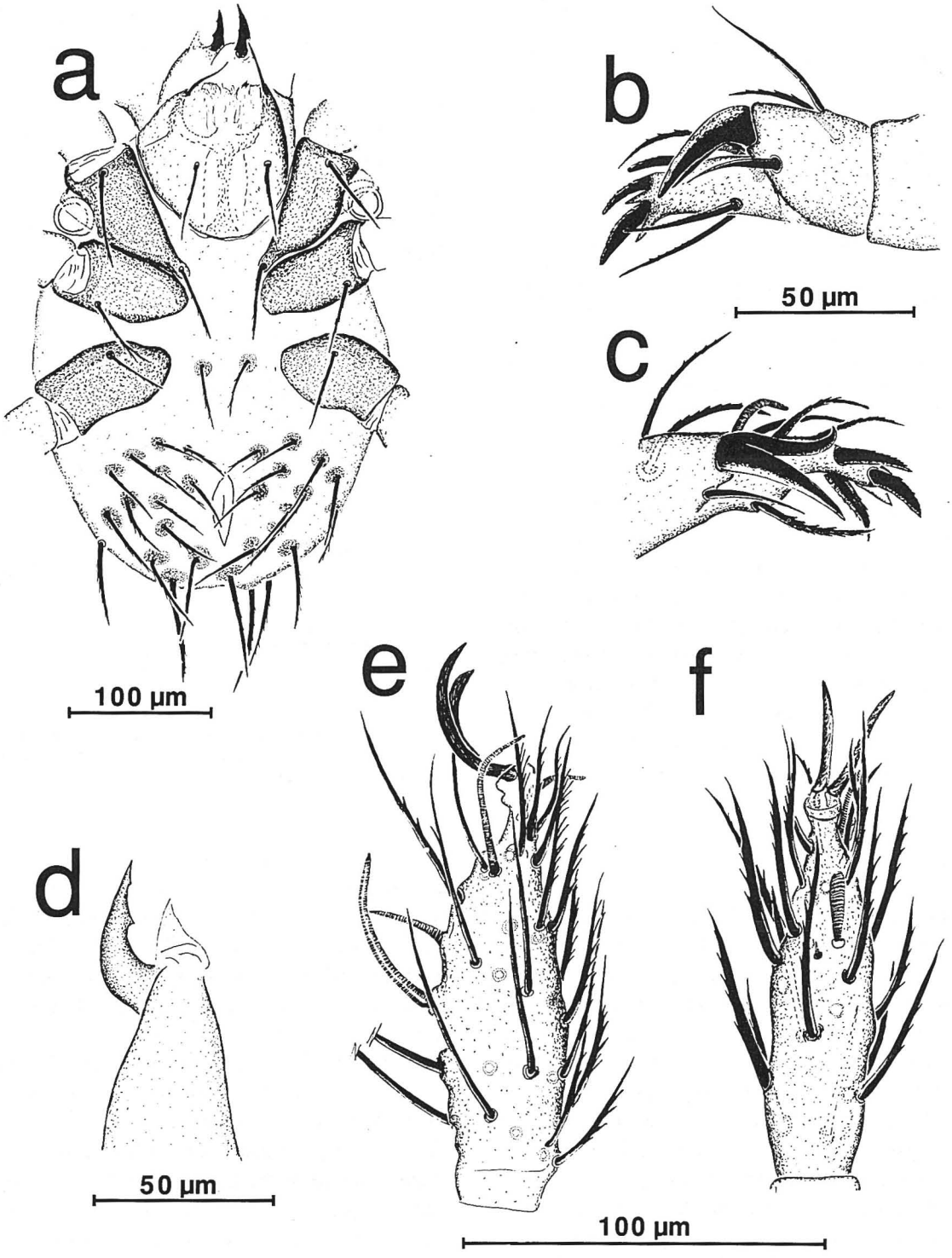

FIG. 4 : *Johnstoniana parva* n. sp., larva.

a. — Habitus, ventral aspect, legs omitted beyond coxae. b. — Tibia and tarsus of palp, viewed anteriorly. c. — Tibia and tarsus of palp, viewed dorsally. d. — Chelicera. e. — Tarsus II, viewed anteriorly. f. — Tarsus II, viewed posteriorly.

	Leg I	Leg II	Leg III
Trochanter	1 (14)	1 (12)	1 (12)
Basifemur	1(13)	2 (12)	2 (12)
Telofemur	4+2s (1)	4+1s (12)	3+1s (1)
	5+1s (1)		4+1s (6)
	5+2s (12)		5+1s (1)
Genu	4+5s+1v (1)	3+1s+1v (1)	4+2s (11)
	4+6s+1v (12)	4+1s+1v (11)	5+1s (1)
	4+7s+1v (1)		
Tibia	6+2s (14)	6+2s (12)	5+1s (2)
			6+1s (10)
Tarsus	31-39+4s (13)	20-28+1s+1cs+1v (12)	17-22 (12)

TAB. 3 : *Johnstoniana parva* n. sp., larva : chaetotaxy of legs. Numbers with no special indication are normal leg setae. Abbreviations : cs = club — shaped solenoidala, n= number of specimens investigated, s = solenoidala, v = vestigiala. Number of cases in brackets.

highest abundance occuring in July. Only two deutonymphs were collected in the field on 26.08.91. Adults were found (1) in early June (females only ; 1991 : N= 1, 1992 : N= 3) and (2) from late August to late October (1990 : N= 14, 1991 : N= 13). Hosts carrying the parasitizing larvae, deutonymphs and adults of *J. parva* were mostly captured within crevices of the markedly structured litter layer of the reed-belt. They were only occasionally observed as free-running epiedaphic.

PARASITISM AND DEVELOPMENT

In the field, the larva of *J. parva* was found to be parasitic on nymphs and adults of three syntopic trombidiid species (Fig. 5, Tab. 4). In most cases, a presently undescribed *Johnstoniana* species was parasitized. This species (*J.* sp. A) is similar in size to *J. errans* and is the object of current investigations (WENDT & EGGERS, in prep.). In one instance (10.06.92), conspecific parasitism was also observed on a *J. parva* adult. Non-trombidiid hosts were never found, despite extensive survey.

A quantitative analysis of the *J.* sp. A hosts revealed infestation rates of 9.1 % (18.07.89, N= 11 hosts), 17.8 % (26.06.90, N= 45), 12.7 % (03.07.90, N= 197), 2.9 % (22.08.90, N= 34), 26.5 % (16.07.91, N= 49) and 14.4 % (24.07.91, N= 132). In most cases (88.1 %, N= 59 hosts) , one larva was attached to the host. In 7 cases (11.9 %), two larvae were found parasitizing the same host. No more than two such larvae were ever observed to parasitize a common host. The larva of *J. parva* showed preference for the dorsal part of the idiosoma (82 %) as the attachment site. Only in a few cases were larvae found on the ventral part of the idiosoma (2 %), the gnathosoma (8 %) or the legs (8 %).

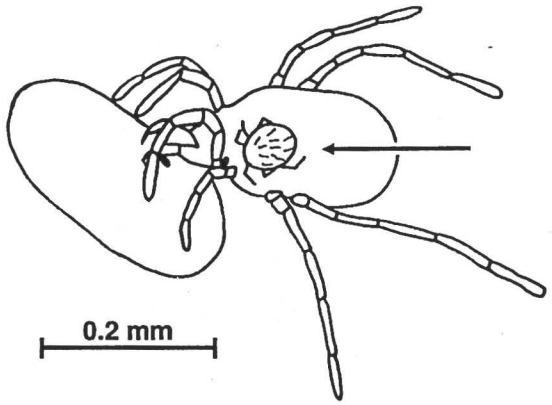

FIG. 5 : *Johnstoniana parva* n. sp. : larva parasitizing an adult *Johnstoniana sp.*, adult preying on an ant larva. Drawing traced from a photograph.

Laboratory experiments on the host spectrum of *J. parva* confirmed the successful conspecific parasitism of a hatched larva on a deutonymph of the same species. No parasitism was observed for *Allothrombium fuliginosum*, *Platytrombidium sylvaticum* or *Calyptostoma velutinus*. Non — acarine hosts were never accepted.

The parasitic bonding of the larva, while sucking, is not very strong. Sometimes individuals move their legs and idiosoma. In the laboratory, at 20 ° C, the parasitic phase of field-borne larvae on their hosts persisted for a maximum of 6 days after capture (average of 4 days). Its duration is temperature dependent (Tab. 5). Laboratory reared larvae successfully parasitized *J. tuberculata* deutonymphs for an average of 7 days at 20 ° C (N= 7, minimum 6 days, maximum 9 days). The

HOSTS	NUMBER OF OBSERVATIONS	AVERAGE PARASITE LOAD	MAXIMUM PARASITE LOAD
Johnstonianidae:			
Centrothrombidium schneideri AD	1	1	1
Johnstoniana parva AD	1	1	1
J. sp. A AD, DN	59	1.03	2
Microtrombidiidae:			
Platythrombidium sylvaticum AD	1	1	1

TAB. 4 : *Johnstoniana parva* n. sp. : parasitic associations of the larva. The data was obtained from field records. Abbreviations : DN = deutonymph, AD = adult.

parasitism has no obvious direct effect on the vitality of the hosts when sufficient food is provided. Other effects on the hosts (e.g. fertility) were not checked. After detaching from the host, the larva remains active for 1 day on average (Tab. 5) before developing to the calyptostatic protonymphal instar. In several cases during this time, it was observed that fed larvae were preyed upon by their johnstonianid hosts. The same was true for freshly emerged larvae when placed together with adult or deutonymphal *J.* spp.. At the beginning of the protonymphal instar the larvae stretch their first legs upward and remain in that position. The protonymphal instar at 20 ° C lasts 10 days on average and is temperature dependent (15 ° C : 16 days ; Tab. 5).

Each emerging active deutonymph, when fed with *Drosophila* larvae, consumed on average one *Drosophila* larva (size 1-2 mm) every second day. This instar lasts on average 14 days at 20° C which once again can be prolonged by lowered temperatures.

At the beginning of the calyptostatic tritonymph, the deutonymphs raise their first legs in the same manner as the larvae. The tritonymph lasts 12 days at 20 ° C (20 days at 15 ° C ; Tab. 5).

Adults were again fed with *Drosophila* larvae. They died in the laboratory after a maximum time of 32 days at 20 ° C (42 days at 15 ° C). At 4 ° C, adults survived for up to 230 days, after which time at 15 ° C the maximum survival time was 34 days.

In one rearing box containing males and females, spermatophores were deposited on the wet substratum. They were deposited along with smaller signal stalks which usually lack sperm cells as described by WITTE (1984) for *J. errans*. Firstly, 2-3 signal stalks are deposited forming a zigzag-track, followed by the secretion of a spermatophore. A few signal stalks later, a second, and sometimes even a third,

ONTOGENETIC INSTAR	NUMBER OF OBSERVATIONS	AVERAGE DEVELOPMENTAL TIME [DAYS]	MINIMUM DEVELOPMENTAL TIME [DAYS]	MAXIMUM DEVELOPMENTAL TIME [DAYS]
Larva				
1. parasitic phase	34 (10)	4 (6)	0 (2)	6 (8)
2. postparasitic phase	34 (10)	1 (1)	0 (0)	3 (3)
Protonymph (calyptostatic)	34 (9)	10 (16)	8 (14)	13 (19)
Deutonymph	11 (4)	14 (24)	10 (19)	19 (30)
Tritonymph (calyptostatic)	16 (3)	12 (20)	10 (20)	14 (21)
Maximum lifespan female				32 (42)

TAB. 5 : *Johnstoniana parva* n. sp. : developmental times (means) of the ontogenetic instars in laboratory. Animals were reared in a lightthermostat at 20 ° C (15 ° C) with a 12h light/12h dark photoperiod and 100 % relative humidity.

spermatophore is deposited in a similar fashion. This row is terminated after 2-3 signal stalks. Males from the field secreted spermatophores in September.

Nine days after sperm-uptake, a female started laying eggs. These were bright orange in colour with a diameter of 250 µm. In the laboratory, they were deposited individually on the substratum, mostly at night. One female deposited 30 eggs over a period of 20 days in October. With commencement of the oviposition period, females ceased all feeding. All females died 15 — 20 days after the last oviposition ; all males having already died by then. In rearing experiment (1) 10 % of the eggs grew to larvae and hatched over a period of 28 to 58 days after egg deposition.

For rearing experiment (2) a larval hatching rate of 50 % was found, the larvae emerging asynchronously between 184 and 218 days after egg deposition. The eggs of rearing experiment (3) all developed to larvae with a high synchronisation between the 12th and 15th day after the last change of hatching conditions (Fig. 6).

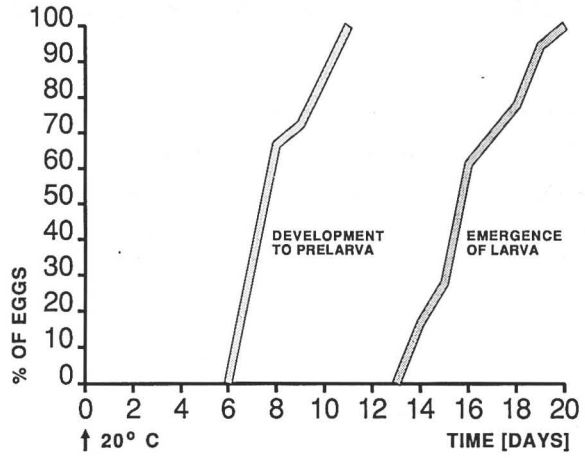

FIG. 6 : *Johnstoniana parva* n. sp. : synchronisation of egg development after the following, successive rearing regimes : 53 days/15 ° C/6h light/18h dark, 46 days /15 ° C/10h light/14h dark, 127 days/4 ° C/darkness, 20 ° C / darkness.

It was observed that eggs only develop under conditions of saturated air humiditity, otherwise they dried out within a short time. Additional hatching experiments revealed that egg development also takes place under submerged conditions. The emerging larvae penetrate the water surface and are able to move on it and to leave it. At 20 ° C in darkness, unfed larvae showed survival times of 27-28 days (N= 4).

DISCUSSION

Taxonomy : Although most of the descriptions of other *Johnstoniana* species appear to be inadequate for the purposes of clear identifications (NEWELL, 1957), we are nevertheless sure that *Johnstoniana parva* n. sp. constitutes a new, previously undescribed species. It differs from *J. tuberculata* in the deutonymph and adult instars by the absence of setulose setae on tarsus I, the lower number of setae on the genital valves and the dorsal and ventral idiosomalae having approximately the same length. The larva differs by its larger size and shape of the palp claws and by having an additional strong hook on the cheliceral blade. Moreover, its parasitism and life cycle is different to that of *J. tuberculata*. *J. parva* differs from all remaining *Johnstoniana* species by smaller size of its sclerites in all instars and by different insertion of idiosomal setae in the deutonymph and adult instars.

We realize that a complete description should include information about the phenotypic variability within the geographical range of a species. Unfortunately this information is not available, since *J. parva* has been studied only from lake " Wittensee ".

The occurrence of three syntopic *Johnstoniana* species (*J. tuberculata*, *J. parva*, *J.* sp. A) within a very small area (lake " Wittensee ") endorses the view of SOUTHCOTT (1961), that assuming isolated instars from the field to be conspecific, without proper confirmation through controlled rearing experiments, is unsatisfactory. Unfortunately, such erroneous " habitat correlations " crop up quite often in the literature.

Biology : As in all other species of the genus, all instars of *J. parva* are restricted to wet places. The low number of deutonymphs and adults captured in the field may be due to the less accessible habits of these instars.

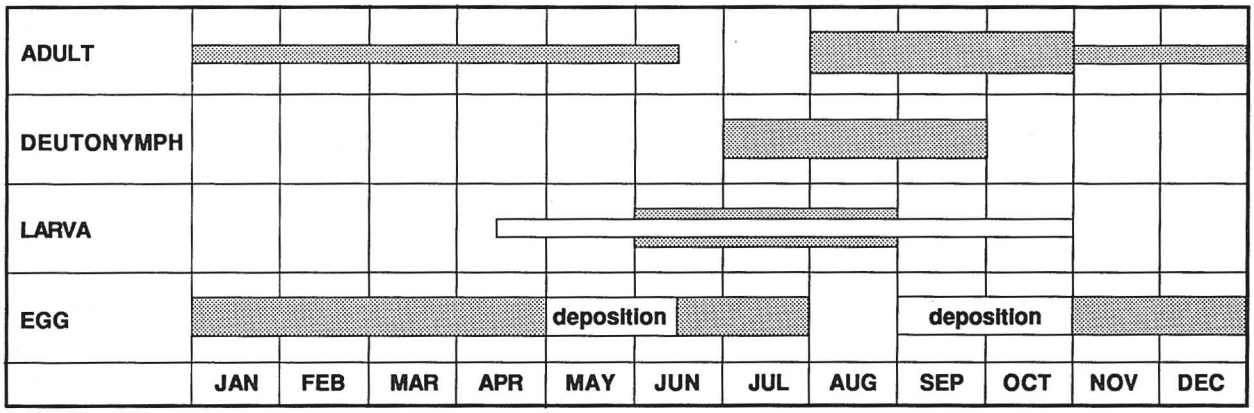

FIG. 7 : *Johnstoniana parva* n. sp. : generalized phenology of the active instars and eggs (filled columns). The duration times of the respective occurance was reconstructed from field observations and from development data obtained in the laboratory. A portion of the female population obviously hibernates, depositing eggs during late spring (narrow filled columns). Seasonal occurrence of larval hosts is indicated by open column.

J. parva is an univoltine species (Fig. 7). There may be two oviposition periods. Apparently, a portion of the female population deposits eggs in September and October, after insemination. These eggs survive the winter in diapause, and a synchronized hatching of the larvae occurs in spring. Another portion of the female population deposits eggs after hibernation, during the spring of the following year. These eggs take about a month to develop, with larvae emerging in summer. These assumptions are supported by the following facts :

(1) Males deposit spermatophores soon after emergence even in the absence of females. It has been found that for *J.* sp. A these are also secreted at low temperatures (8 ° C) (WITTE, pers. comm.). Males were never found to survive wintertime in the laboratory, nor could they be collected in the field during spring.

(2) Females started egg deposition in laboratory soon after sperm uptake at 15 ° C and above. At 4 ° C no such deposition took place.

(3) In the laboratory females hibernated at low temperatures (4 ° C). Ovigerous females could be collected in the field in late spring. These females must have hibernated. In the case of the 1991 adult after capture, eggs are deposited during this time. Larvae hatched from these eggs after a month.

(4) Information on the seasonal occurrence of the larvae in the field does not correlate with the laboratory data on synchronization of larval emergence after temperature increase.

These two modes of egg deposition are dependent on the seasonal emergence of the females and the time of insemination. Early inseminated females will still be able to deposit eggs in the year of emergence, given adequate temperatures. On the other hand, later inseminated females hibernate at low temperatures, and will not be able to deposit eggs until the following spring. In both cases, insemination occurs in the year of emergence.

Some hibernating females, reared under the same conditions as the females which deposited eggs after emergence in autumn, failed to start the oviposition period in spring. Instead, they reabsorbed the eggs and died within two weeks. This is probably due to the absence of proper environmental cues under laboratory conditions.

While the larvae of other *Johnstoniana* species seem to regularly parasitize tipulid imagos, the restricted parasitism of *J. parva* on trombidioid mites has not yet been observed in other species of this genus. A larva found parasitizing on an adult *J. errans* was described by WILLMANN (1951) as an exceptional case of conspecific parasitism. We, however, believe it to be a larva of *J. parva* or

another *Johnstoniana* species with a similar mode of host selection. The same might be true concerning two parasitengonid larvae on *J. errans* var. *saxonia* mentioned by FRANKE (1940). At the very least, the larva of *J. tuberculata* has never been observed to parasitize trombidioid mites (WOHLTMANN et al., in press). Parasitengonid larvae parasitizing other parasitengonid mite species have previously been recorded only for *Grossia onychia* Womersley on *Chyzeria australiensis* Hirst (WOMERSLEY, 1954 teste WELBOURN, 1983), *Allothrombium* spp. on *Balaustium* sp. (WELBOURN, 1983), *Leptus trimaculatus* (Hermann) on *Abrolophus* sp. (WENDT et al., 1992) and *L. ignotus* (Oudemans) on *Balaustium globigerum* Berlese (OUDEMANS, 1912). Concerning the species status of *L. ignotus*, we refer to the discussion in WENDT et al. (1992).

Most parasitengonid larvae parasitize imagos of flying insects (WELBOURN, 1983). However, parasitism on this type of host increases the risk of being displaced into unsuitable biotopes. This applies particularly to those species which are restricted to comparatively smaller habitats, e.g. wet zones along limnic waters. Thus, the parasitism of *J. parva* may be seen as a step towards minimizing this risk since it parasitizes only low-dispersative hosts which are also strongly restricted to wet habitat conditions. This, however, presents one drawback i.e. a reduced capacity for dispersal. The main-host of *J. parva* in the area of investigation, *J.* sp. A, potentially preys on the larva. The risk of being preyed upon is negligible when compared to the advantage of habitat retention.

The duration of the calyptostatic stages is fixed and depends only on temperature, whereas the duration of the deutonymph is dependent on both the temperature and availability of food as in the case of *J. tuberculata* (WOHLTMANN et al., in press). The males start to deposit spermatophores soon after emergence. The mode of spermatophore deposition resembles that of *J. tuberculata.*

Rearing experiment (1) clearly shows that eggs deposited during autumn had to pass through an obligatory diapause. A hatching rate of about 10 % under constant light and temperature conditions is regarded as failed hatching. Nevertheless, it still yields information about the minimum developmental time for eggs, which is about 4 weeks. This is consistent with the data of ROBAUX (1971) for *Allothrombium fuliginosum*, *Trombidium holosericeum* (L.) and *T. mediterraneum* (Berlese).

This failed hatching was also observed in experiment (3) in the case of one larva.

In rearing experiment (2) an increased hatching rate of 50 % was observed, which can obviously be attributed to changing light conditions. The variation of light exposure, in order to simulate natural seasonal changes, reactivated development in at least some of the eggs. Nevertheless, we cannot wholly ignore the possibility of failed hatching because of the small number of eggs examined. Rearing experiment (3) additionally showed that under temperature variation, consistent with seasonal changes (natural fluctuations notwithstanding), a hatching rate of 100 %, combined with a high synchronization of larval emergence, resulted.

The larva of *J. parva* has a broad seasonal occurrence which is also the case for the potential hosts. Although *J.* sp. A is probably the most suitable host for *J. parva* because of its restriction to wet habitats (WENDT, in press), dependence on only one host-species could be risky for the survival of the species. Lower host-specificity might be a good tactic, ensuring species survival during probable times of low main-host abundance.

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