Comp. Parasitol.
73(1), 2006, pp. 7–13

Paradeuterobaris victoriae n. sp. (Digenea: Microscaphidiidae) and *Buckarootrema minuta* n. sp. (Digenea: Pronocephalidae) from the Victoria River Red-Faced Turtle, *Emydura victoriae* (Pleurodira: Chelidae) in Australia

SCOTT D. SNYDER[1,3] AND VASYL V. TKACH[2]

[1] Department of Biology, University of Nebraska at Omaha, Omaha, Nebraska 68182, U.S.A.
(e-mail: sdsnyder@mail.unomaha.edu) and
[2] Department of Biology, University of North Dakota, Grand Forks, North Dakota 58202, U.S.A.
(e-mail: vasyl.tkach@und.nodak.edu)

ABSTRACT: *Paradeuterobaris victoriae* n. sp. (Digenea: Microscaphidiidae) and *Buckarootrema minuta* n. sp. (Digenea: Pronocephalidae) are described from the Victoria River red-faced turtle, *Emydura victoriae* (Pleurodira: Chelidae), from the Victoria River, Northern Territory, Australia. Each of the new species is the second known member of a previously monotypic genus. *Paradeuterobaris victoriae* n. sp. differs from *Paradeuterobaris novaguineae* in the extent of the vitellarium and ventral glands, the position of the testes, and the presence of numerous uterine loops between the anterior testis and seminal vesicle, among other characters. *Buckarootrema minuta* n. sp. differs from *Buckarootrema goodmani* in the relative length of the ceca, the relative position of the gonads and testes, the position of uterine loops, the number of eggs, and overall body size. This work is the first report of any parasite from the Victoria River red-faced turtle and the first report of endohelminths from turtles of Northern Territory.

KEY WORDS: Platyhelminthes, Digenea, Microscaphidiidae, Pronocephalidae, *Paradeuterobaris victoriae*, *Buckarootrema minuta*, *Emydura victoriae*, turtle, parasite, Northern Territory, Australia.

Australian freshwater turtle parasites have been the subject of a recent flurry of activity on the part of taxonomists. Twenty of the 39 recognized parasite species have been described since 1994 (Platt and Pichelin, 1994; Pichelin, 1995; Platt and Blair, 1996; Cribb and Pichelin, 1997; Jue Sue and Platt, 1998; Pichelin et al., 1998, 1999; Ferguson et al., 1999; Jue Sue and Platt, 1999a, b; Ferguson et al., 2001; Platt and Brooks, 2001; Platt, 2003; Platt and Tkach, 2003); however, the parasites of Australian turtles remain poorly known. Of the 25 species of freshwater turtles in Australia (Cogger, 2000) only 9 have been reported as hosts and only 4 species (*Emydura macquarii*, *Elseya latisternum*, *Emydura krefftii*, and *Chelodina expansa*) have been found to host more than 10 parasite species. Moreover, most of the parasite descriptions and reports come from turtles collected in southern Queensland or New South Wales. No endoparasites and only 1 ectoparasite (a leech; Samure and Doody, 2000) have been reported from Northern Territory, a state with 10 turtle species (Cann, 1998).

The Victoria River red-faced turtle, *Emydura victoriae* (Gray, 1842), occurs in tropical northern Australia from the Fitzroy River, Western Australia, to the Daly River, Northern Territory (Georges and Thomson, 2003). There are no published reports of parasites from this turtle. In June 2004, we collected a number of digeneans belonging to several genera and at least 4 different families from 3 specimens of *E. victoriae* collected during a preliminary examination of the parasite fauna of Northern Territory turtles. Some of these worms appear to be new to science. Two of them are described herein. This work is the first report of parasites from the Victoria River red-faced turtle and the first report of helminths from turtles of the Northern Territory, Australia.

MATERIAL AND METHODS

Three *E. victoriae* were collected in crab traps baited with tinned sardines from the Victoria River in Gregory National Park, Northern Territory, Australia, under a collecting permit from the Northern Territory Parks and Wildlife Commission. A total of 26 specimens of a new digenean species belonging to Pronocephalidae was recovered from 1 red-faced turtle, and 4 specimens of a new species belonging to Microscaphidiidae were collected from the small intestine of the other 2 red-faced turtles. Living worms were rinsed in saline, briefly examined before fixation, killed with hot water, and fixed in 95% ethanol. Specimens were stained with aqueous alum carmine, dehydrated in a graded ethanol series, cleared in clove oil, and mounted permanently in Damar balsam.

All measurements are in micrometers unless otherwise stated.

[3] Corresponding author.

Paradeuterobaris victoriae n. sp. (Figs. 1–4)

Description

A single adult and 3 immature specimens of this species were recovered from the intestines of 2 individuals of *E. victoriae*. Despite the limited material, differences between these specimens and the only other known species of *Paradeuterobaris* Blair and Rose, 1986, clearly distinguish *P. victoriae* n. sp. as a novel species. The description and measurements of the adult holotype are given below.

Body elongate, linguiform, with narrow anterior end and rounded posterior end. Body length 7.15 mm, maximum body width slightly posterior of posterior testis 730. Tegument rather thin, smooth, unspined. Rounded glands of different size situated on ventral side of body from approximately level of intestinal bifurcation to posterior end of body. Larger glands arranged in irregular longitudinal rows (9–10 rows in middle part of body), smaller glands situated in unordered manner.

Oral sucker terminal, 190 × 140, with deep cavity and without diverticula. Esophagus almost straight, 1.12 mm long, with thickening of muscular wall, 115 × 85, at posterior end. Intestinal bifurcation 1.3 mm from anterior end of body. Ceca extend into posterior half of body and end at level of ovary, 1.25 mm from posterior end of body.

Testes 2, preovarian, in anterior part of posterior half of body, slightly diagonal, almost tandem, irregularly lobed. Testes situated at 1 testis diameter from each other. Anterior testis 450 × 540, posterior testis 450 × 530. Seminal vesicle long, extensively coiled, free in parenchyma posterior to intestinal bifurcation. Prostatic duct long, from approximately level of intestinal bifurcation to genital pore. Genital pore at about one-third distance between oral sucker and intestinal bifurcation.

Ovary small, subspherical, 130 × 160, situated at level of ends of ceca, 1.14 mm from posterior end of body and 850 posterior of posterior testis. Mehlis' gland and ootype medial and slightly posterior to ovary. Uterus intercecal, first forming coils between ovary and posterior testis, then passing between testes and forming several coils between anterior testis and seminal vesicle. Metraterm thin-walled begins just posterior to intestinal bifurcation. Vitellarium of relatively large follicles aligned in 2 lateral extracecal rows and extending from near level of anterior margin of anterior testis to somewhat beyond ends of ceca. Vitelline fields do not merge at any point but form U-shaped structure interrupted at posterior arched end by ootype and Mehlis' gland. Some vitelline follicles surround ovary and ends of ceca posteriorly. Vitelline reservoir just posterior to ootype. Eggs 120–130 × 58–65.

Excretory pore at 400 from posterior end of body, surrounded by large muscular sphincter. Excretory bladder small sac-like, 400 × 200, consisting of 2 short arms of unequal length. Main excretory canal originates at top of each arm. Canal first directed backward and then turns and runs anteriorly giving lateral branches. Complete organization of excretory canal system impossible to examine in detail.

Taxonomic summary

Type host: Victoria River red-faced turtle, *Emydura victoriae* (Gray, 1842) (Chelonia: Pleurodira: Chelidae).

Type locality: Victoria River at Victoria Highway, Gregory National Park, Northern Territory, Australia, 15°36.85′S, 131°7.86′E.

Site of infection: Intestine.

Prevalence and intensity of infection: Two of 3 (66.6%) *E. victoriae* were infected with 2 worms each.

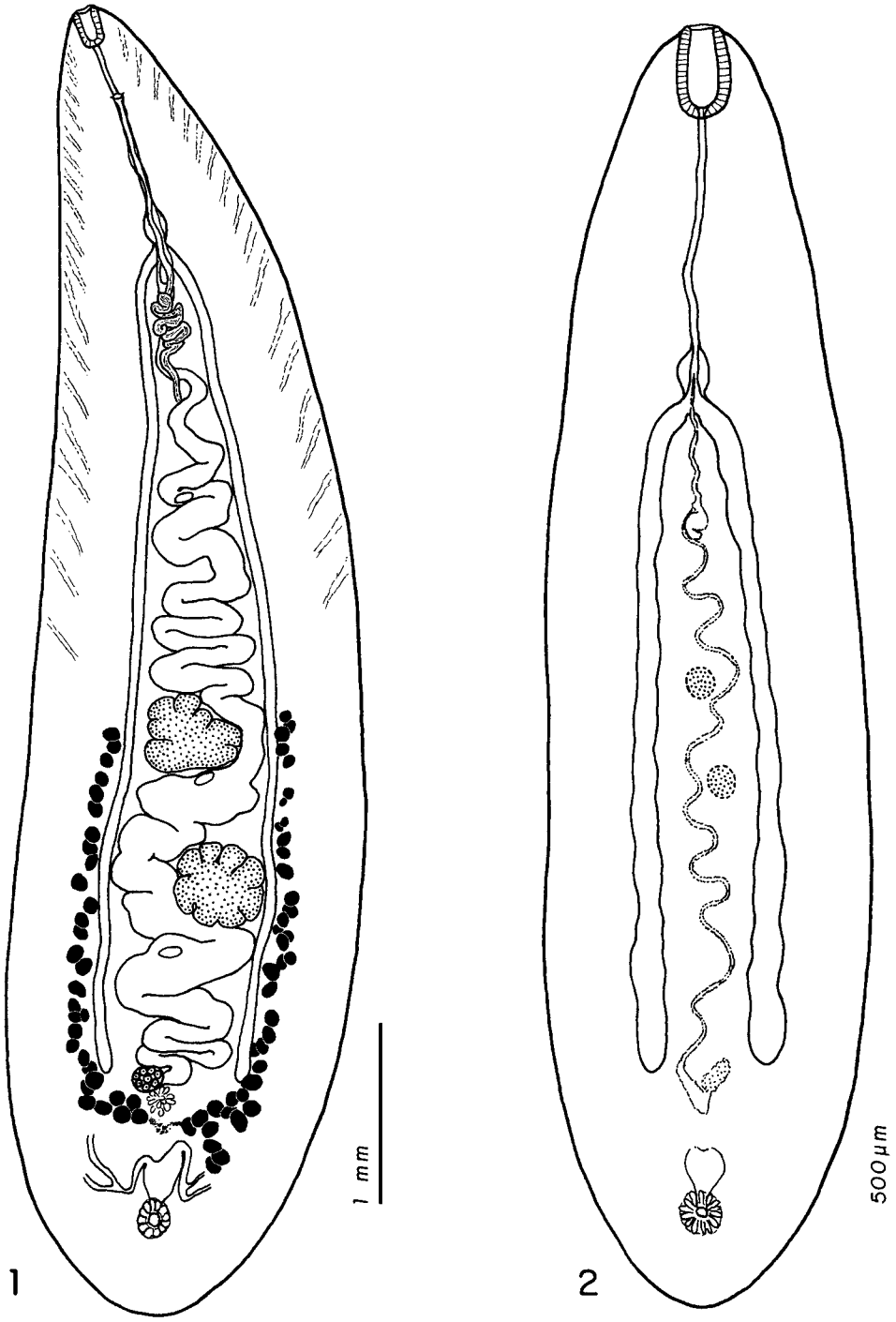
Specimens deposited: The type series consists of 1 fully mature and 1 immature specimen. Holotype: Queensland Museum (QM) G 225318; paratype QM G 225319. Both labeled identically: ex. *Emydura victoriae*, Gregory National Park, Northern Territory, Australia, June 2004.

Etymology: The specific epithet refers to the turtle and the river from which this species was collected.

Remarks

Immature worms showed the general morphologic characteristics of the adult parasite; however, the ovary and vitellarium were not yet developed. Although 1 immature specimen was only 1.70 mm long, its oral sucker size (120 × 80) was already close to that of the adult specimen. The position of the testes and uterine primordia corresponded to that of the adult as well (Figs. 1, 2).

On the basis of general morphology, the new species clearly belongs to Microscaphidiidae. Overall body shape and position of the internal organs of the new species most closely resemble those of *Paradeuterobaris novaguineae* Blair and Rose, 1986, the only previously recognized representative of this genus, described from *Carettochelys insculpta* in New Guinea. Although general features of the 2 species



Figures 1, 2. *Paradeuterobaris victoriae* n. sp. **1.** Holotype. **2.** Juvenile specimen.

Figures 3, 4. *Paradeuterobaris victoriae* n. sp. **3.** Arrangement of the ventral glands in the holotype (fixed, unstained specimen). **4.** Morphologic details at the posterior part of the body in the holotype (stained specimen). Note that the lateral excretory canals begin at the apical part of the excretory bladder.

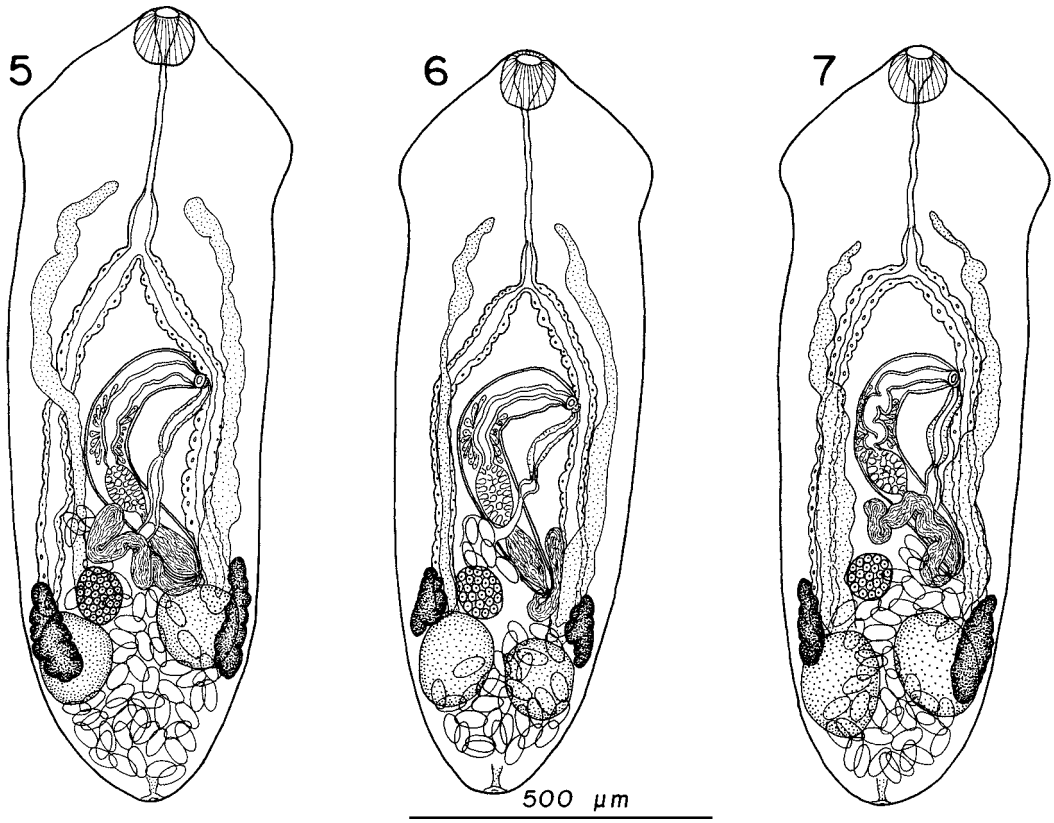
are similar, *P. victoriae* n. sp. can be readily differentiated from *P. novaguineae* by the extent of the ventral glands and vitelline fields. In the new species, the anterior extreme of the ventral glands almost reaches the level of the intestinal bifurcation (Fig. 3), whereas in *P. novaguineae*, the anterior extreme of these glands is far posterior, just anterior of the anterior testis (Blair and Rose, 1986). The anterior border of the vitelline field in the new species is at the level of the anterior margin of the anterior testis (Fig. 1), but in *P. novaguineae*, the vitelline border is posterior to the posterior testis. The testes in *P. victoriae* n. sp. are shifted posterior compared with *P. novaeguineae*, and in the new species, the testes lay apart by approximately 1 testis diameter. In *P. novaguineae*, the testes are closely adjacent. The seminal vesicle in the new species is situated much farther from the anterior testis than in *P. novaguineae*. The uterus in *P. victoriae* n. sp. forms numerous coils between the anterior testis and the seminal vesicle, but very few uterine coils can be observed between anterior testis and the seminal vesicle in *P. novaguineae*. Because of limited material, we prefer not to discuss potentially variable metric characters but to focus on qualitative characters that allow differentiation among these species.

Buckarootrema minuta n. sp. (Figs. 5–7)

Description

Description based on 11 adult specimens. Not all characters could be observed well enough in all specimens to make measurements. Measurements of the holotype are given in the text; measurements of the entire type series are given in Table 1.

Body small, anterior end with well-developed incomplete cephalic collar, posterior end rounded; tegument unarmed. Body length 675, maximum width at level of cephalic collar 230. Oral sucker spherical, 50 in diameter, mouth opening slightly subterminal. Thin esophagus 150 long, with bulb-like widening just anterior to cecal bifurcation. Cecal walls comprise large gland-like cells. Ceca terminate 160–165 from posterior end of body, at anterior margins of testes or slightly overlapping them. Oval or rounded testes opposite to slightly oblique, situated in posterior half of body at terminus of ceca. Both testes 75 × 60. Cirrus sac large, 255 × 38, with proximal end near anterior margin of left testis. Proximal portion of cirrus sac straight whereas distal portion curved, opening into genital atrium situated ventral to left cecum 315 from anterior end of body. Cirrus sac contains internal seminal vesicle, an oval prostatic



Figures 5–7. *Buckarootrema minuta* n. sp. **5.** Holotype. **6, 7.** Paratypes.

region containing glandular droplet-like cells and ejaculatory duct; evaginated cirrus not observed. External seminal vesicle elongate and occasionally coiled with variable orientation.

Ovary oval or rounded, 50 × 45, situated between right testis and proximal part of cirrus sac. Vitellarium consists of 2 compact follicular masses of variable shape (usually elongate) at anterior distal sides of each testis. Approximately one half to two thirds of vitelline masses overlap testes. Right follicular mass 88 long, left follicular mass 100 long. Thick-walled uterus coils mainly postovarian and postcecal. Eggs posterior to ovary with very few extending anterior. Muscular metraterm 80 long, begins about midpoint of cirrus sac. Uterus opens into genital atrium near male genital opening. Eggs oval, 30–31 × 13, with long polar processes. It was impossible to adequately measure the polar process length on total mounts. Excretory pore terminal; excretory bladder Y-shaped with short stem and long arms reaching anterior to intestinal bifurcation.

Taxonomic summary

Type host: Victoria River red-faced turtle, *Emydura victoriae* (Gray, 1842) (Chelonia: Pleurodira: Chelidae).

Type locality: Victoria River at Victoria Highway, Gregory National Park, Northern Territory, Australia, 15°36.85′S, 131°7.86′E.

Site of infection: Small intestine.

Prevalence and intensity of infection: One of 3 (33.3%) *E. victoriae* was infected with 26 worms.

Specimens deposited: The type series consists of 11 fully mature specimens. Holotype: QM G 225312; paratypes: QM 225313–225317, Harold W. Manter Laboratory HWML48166 (5 specimens on 2 slides). Both labeled identically: ex. *Emydura victoriae*, Gregory National Park, Northern Territory, Australia, June 2004.

Etymology: The specific epithet refers to the small size of this parasite when compared with the congeneric *B. goodmani*.

Table 1. Metric data for *Buckarootrema minuta* n. sp.

Character (μm)	*n*	Range	Mean	SD	CV
Body length	11	570–675	611.3	31.5	5.2
Body width*	11	210–230	220.0	7.7	3.5
Oral sucker length	9	48–52	50.0	1.0	2.0
Oral sucker width	9	46–50	49.6	1.3	2.7
Esophagus	10	126–150	138.1	7.2	5.2
Right cecum from posterior end	10	140–165	149.3	9.4	6.3
Left cecum from posterior end	10	138–160	147.0	8.9	6.1
Right testis length	9	72–85	76.7	6.7	8.4
Right testis width	9	60–75	66.1	4.6	6.9
Left testis length	9	65–80	73.2	5.5	7.6
Left testis width	9	58–70	63.7	3.6	5.7
Cirrus sac length	11	230–255	241.1	8.2	3.4
Cirrus sac width	10	36–40	37.9	1.0	2.6
Genital pore from anterior end	10	260–315	277.3	17.7	6.4
Ovary length	11	40–53	45.0	4.4	9.8
Ovary width	11	32–45	37.9	3.6	9.7
Right vitellarium length	9	60–92	77.2	10.7	13.3
Left vitellarium length	8	62–100	81.4	10.8	13.3
Metraterm	8	73–82	77.6	3.0	3.8
Egg length	33	28–31	30.1	0.5	1.8
Egg width	33	13–15	13.3	0.5	3.5

* Body width measured at the level of the cephalic collar.

Remarks

The new species is circumscribed within *Buckarootrema* Platt and Brooks, 2001, on the basis of a curved cirrus sac, compact vitelline masses overlapping the testes, position of the uterus and gonads, and numerous other characters. Although the new species closely resembles *B. goodmani* Platt and Brooks, 2001, the 2 species can be readily differentiated by a combination of qualitative and quantitative characters.

The gonads of *B. minuta* n. sp. are clustered much more tightly than in *B. goodmani* and form a compact group at the posterior region of the body. Vitelline masses in the new species usually overlap the testes substantially (sometimes up to two thirds of their length), whereas in *B. goodmani*, the vitelline masses are situated just anterior to or only slightly overlapping the testes. The ovary in *B. minuta* n. sp. is situated at the proximal end of the cirrus sac, but in *B. goodmani*, the ovary is distinctly posterior to the cirrus sac. The anterior margins of the vitellarium in the new species are at the proximal end of the cirrus sac, whereas in *B. goodmani*, these margins are substantially posterior to this level. The ceca in *B. minuta* n. sp. always reach anterior margins of testes, whereas in *B. goodmani*, they terminate anteriorly, only rarely reaching the anterior testicular margins (Platt and Brooks, 2001). *Buckarootrema goodmani* is characterized by a large uterus with numerous eggs that extend from the posterior margins of the testes to the midpoint of the cirrus pouch. Uterine coiling in *B. goodmani* is most pronounced anterior to the testes, which are shifted posteriorly compared with the testes of *B. minuta* n. sp. In *B. minuta* n. sp., eggs are fewer in number than in *B. goodmani*, few eggs lie anterior of the ovary, and the uterus is much less developed than in *B. goodmani*, with most uterine coils situated posttesticular or at the level of testes.

Among metric characters, *B. minuta* n. sp. differs from *B. goodmani* by smaller body size (the largest specimens of the new species are smaller than the smallest species of *B. goodmani*), sucker size, and esophagus length. Despite the differences in the body size of the 2 species, their cirrus sac length is almost identical; however, cirrus sac width (or diameter) is much larger in *B. goodmani* than it is in *B. minuta* n. sp. Gonads are smaller in the new species, but we do not want to overemphasize differences in gonad size because these characters tend to vary in digeneans according to the age and method of fixation of individual worms.

Characters were generally stable among the specimens of *B. minuta* n. sp. examined. The shape and position of the gonads, cirrus sac, and ceca were consistent, although the shape and, to a lesser extent, position of the vitellarium were variable (Figs. 5–7). Sucker size, cirrus sac length, egg size, and body size were among the most stable metric characters according to calculations of both standard deviation and coefficient of variation. Length of vitelline masses was the most variable metric character by these same measures (Table 1).

DISCUSSION

Paradeuterobaris victoriae n. sp. and *B. minuta* n. sp. are the first parasites reported from *E. victoriae* and the first platyhelminth parasites reported from freshwater turtles of the Northern Territory. Both represent the second species described in their respective genera and the generic diagnoses remain intact. *Buckarootrema goodmani* was collected from *E. macquarii* from extreme southeast Queensland (Platt and Brooks, 2001), some 2,500 km from the type locality of *B. minuta* n. sp. The presence of congeneric parasites in congeneric turtles separated by great distance suggests that these parasite species arose in allopatry and that additional species of *Buckarootrema* might be found in the *Emydura* species of Australia and New Guinea.

Paradeuterobaris novaeguineae was described from the pig-nosed turtle, *C. insculpta*, in New Guinea. The Australian distribution of *C. insculpta* is

limited to a few Northern Territory Rivers, including the Victoria (Georges and Thomson, 2003). This turtle, the sole representative of a family once widely distributed in the northern hemisphere, is Australia's only hidden-necked turtle (Cryptodira) and is thought to have entered Australia from New Guinea (Cogger and Heatwole, 1981). It is currently unclear whether *Paradeuterobaris* represents an evolutionary lineage of turtle parasites brought to Australia from New Guinea or a lineage taken to New Guinea by Australian turtles migrating over a late Pleistocene land bridge (Georges and Thomson, 2003). Additional collection of turtle parasites from both Australia and New Guinea can shed light onto questions of both host and parasite biogeography and are likely to reveal additional new species of *Paradeuterobaris*, *Buckarootrema*, and numerous other parasite genera.

ACKNOWLEDGMENTS

The authors thank Drs. Sara Brant and Sam Loker of the University of New Mexico for collection assistance. We also thank Dr. Lois Small of Northern Territory Primary Fisheries and Industries for the use of laboratory space. This work was supported by the University Committee on Research of the University of Nebraska at Omaha (S.D.S.), the National Science Foundation through North Dakota EPSCoR (grant 0132289, V.V.T.), and the Biodiversity Surveys and Inventories Program (NSF-0515460, S.D.S. and V.V.T.).

LITERATURE CITED

Blair, D., and M. Rose. 1986. *Paradeuterobaris novaguineae* gen. et sp. n., (Digenea: Microscaphidiidae) from the intestine of *Carettochelys insculpta* Ramsay, 1886 (Reptilia: Chelonia), from Papua New Guinea. Journal of Parasitology 72:232–235.

Cann, J. 1998. Australian Freshwater Turtles. Beaumont Publishing Pty. Ltd., Singapore. 292 pp.

Cogger, H. G. 2000. Reptiles and Amphibians of Australia. Ralph Curtis Books, Sanibel Island, Florida. 808 pp.

Cogger, H. G., and H. Heatwole. 1981. The Australian reptiles: origins, biogeography, distribution patterns and island evolution. Pages 1332–1373 *in* A. Keast, ed. Ecological Biogeography of Australia. Dr. W. Junk, The Hague, Netherlands.

Cribb, T. H., and S. P. Pichelin. 1997. *Notopronocephalus peekayi* gen. et sp. n. (Digenea: Pronocephalidae) from Australian freshwater turtles. Folia Parasitologica 44: 279–282.

Ferguson, M. A., T. H. Cribb, and L. R. Smales. 1999. Life cycle and biology of *Sychnocotyle kholo* n.g., n.sp. (Trematoda: Aspidogastrea) in *Emydura macquarii* (Pleurodira: Chelidae) from southern Queensland, Australia. Systematic Parasitology 43:41–48.

Ferguson, M. A., L. R. Smales, and T. H. Cribb. 2001. A new species, *Pretestis laticaecum*, (Trematoda, Chadorchiidae), from *Emydura krefftii* Gray, 1871 (Pleurodira: Chelidae) from Central Queensland, Australia. Transactions of the Royal Society of South Australia 125:123–127.

Georges, A., and S. Thomson. 2003. Evolution and zoogeography of the Australian freshwater turtles. Pages 281–299 *in* J. R. Merrick, M. Archer, G. Hickey, and M. Lee, eds. Evolution and Zoogeography of Australasian Vertebrates. Australian Scientific Publishing. Sydney.

Jue Sue, L., and T. R. Platt. 1998. Description and lifecycle of two new species of *Choanocotyle* n.g. (Trematoda: Digenea), parasites of Australian freshwater turtles, and the erection of the family Choanocotylidae. Systematic Parasitology 41:47–61.

Jue Sue, L., and T. R. Platt. 1999a. Description and lifecycle of three new species of *Dingularis* n.g. (Digenea: Plagiorchiida) parasites of Australian freshwater turtles. Systematic Parasitology 43:175–207.

Jue Sue, L., and T. R. Platt. 1999b. Description and lifecycle of *Thrinascotrema brisbanica* n.g., n.sp. (Digenea: Plagiorchiida), a parasite of the freshwater turtle *Emydura latisternum* from Australia, and the erection of the family Thrinascotrematidae. Systematic Parasitology 43:217–227.

Pichelin, S. 1995. The taxonomy and biology of the Polystomatidae (Monogenea) in Australian freshwater turtles (Chelidae, Pleurodira). Journal of Natural History 29:1345–1381.

Pichelin, S., T. H. Cribb, and F. V. Bona. 1998. *Glossocercus chelodinae* (MacCallum, 1921) n. comb. (Cestoda: Dilepididae) from freshwater turtles in Australia and a redefinition of the genus *Bancroftiella* Johnston, 1911. Systematic Parasitology 39:165–181.

Pichelin, S., P. M. Thomas, and M. N. Hutchinson. 1999. A checklist of helminth parasites of Australian reptiles. South Australian Museum Monograph Series 5:1–61.

Platt, T. R. 2003. Description of *Auriculotrema lechneri* n. gen., n.sp. (Digenea: Choanocotylidae), a parasite of freshwater turtles (Testudines: Pleurodira: Chelidae) from Queensland, Australia. Journal of Parasitology 89:141–144.

Platt, T. R., and D. Blair. 1996. Two new species of *Uterotrema* (Digenea: Spirorchidae) parasitic in *Emydura krefftii* (Testudines: Chelidae). Journal of Parasitology 82:307–311.

Platt, T. R., and D. R. Brooks. 2001. Description of *Buckarootrema goodmani* n.g., n.sp. (Digenea: Pronocephalidae), a parasite of the freshwater turtle *Emydura macquarii* (Gray, 1830) (Pleurodira: Chelidae) from Queensland, Australia, and a phylogenetic analysis of the Pronocephalidae Looss, 1902. Journal of Parasitology 87:1115–1119.

Platt, T. R., and S. Pichelin. 1994. *Uterotrema australispinosa* n. gen, n. sp. (Digenea: Spirorchidae), a parasite of a freshwater turtle *Emydura macquarii* from southern Queensland, Australia. Journal of Parasitology 80:1008–1011.

Platt, T. R., and V. V. Tkach. 2003. Two new species of *Choanocotyle* Jue Sue and Platt, 1998 (Digenea: Choanocotylidae) from an Australian freshwater turtle (Testudines: Pleurodira: Chelidae). Journal of Parasitology 89:145–150.

Samure, R. A., and J. S. Doody. 2000. *Carretochelys insculpta* (pig-nosed turtle). Ectoparasites. Herpetological Review 31:237–238.