Prevalence of *Kiricephalus pattoni* (Stephens, 1908), in a Taiwanese population of *Anolis sagrei* Duméril & Bibron, 1837, with comments on the infection intensity of this parasite

The intensity (the number of individual parasites in the infected host) and prevalence (the number of infected hosts in the population; often expressed as a percentage), and their respective means and standard deviations, are the most fundamental and therefore important data for studies of parasites in communities (Bush et al. 1997; Rózsa et al. 2000; Smallridge & Bull 2000). In the present note the authors report on the infection intensity and prevalence of the pentastome *Kiricephalus pattoni* (Stephens, 1908) (family Porocephalidae) in a population of the exotic invasive lizard, *Anolis sagrei* Duméril & Bibron, 1837, from southwestern Taiwan.

Anolis sagrei males and females (N = 502) were collected during all months in the period January 2002 to March 2003, from an area surrounding a plant nursery (23.428993° N, 120.483095° E; datum: WGS84) in Santzepu, Sheishan District, Chiayi County, southwestern Taiwan, as part of a study into the diet of this introduced species in Taiwan (Norval et al. 2010). During the dissection of the specimens large parasites were found in the body cavity of four lizards (Table 1). The specimens were photographed and the parasites were removed and placed in 75 % ethanol. When they were later examined under a stereoscopic dissecting microscope it was noted that the cephalothorax of the parasites was enlarged, and that the hook arrangement was in a straight line, with the pear-shaped mouth positioned between the inner hooks. Based on these morphological features, the collection locality and the paper by Christoffersen & De Assis (2013), the parasites were identified as nymphs of the pentastome *K. pattoni*. The infection intensity ranged from one to two, with a mean and standard deviation of 1.25 and 0.5 respectively, and the infection prevalence in the sampled *A. sagrei* males and females was 0.78 % and 0.81 % respec-

Table 1: The lizard and snake species from Santzepu, Sheishan District, Chiayi County, southwestern Taiwan that have been recorded as hosts of the pentastomid *Kiricephalus pattoni* (STEPHENS, 1908), and the intensities of the *K. pattoni* infections (* - the host was not dissected and the parasites were recorded as subcutaneous lumps). The collection date, gender and snout-vent length of the reptiles (SVL, mm) are given.

Date	Family	Species	Sex	SVL	Intensity	Reference
2005/10/01	Agamidae	*Japalura swinhonis* GÜNTHER, 1864	F	64	1*	NORVAL et al. (2014a)
2006/04/20	Agamidae	*Japalura swinhonis* GÜNTHER, 1864	F	67	8*	NORVAL, personal observation
2007/02/26	Agamidae	*Japalura swinhonis* GÜNTHER, 1864	M	72	6*	NORVAL et al. (2014a)
2008/01/10	Agamidae	*Japalura swinhonis* GÜNTHER, 1864	F	58	1*	NORVAL et al. (2014a)
2008/06/17	Agamidae	*Japalura swinhonis* GÜNTHER, 1864	F	66	4	NORVAL et al. (2014b)
2007/03/23	Colubridae	*Amphiesma stolatum* (LINNAEUS, 1758)	F	496	2*	NORVAL et al. (2014a)
2007/03/30	Colubridae	*Amphiesma stolatum* (LINNAEUS, 1758)	F	519	1*	NORVAL et al. (2014a)
2007/03/30	Colubridae	*Amphiesma stolatum* (LINNAEUS, 1758)	F	423	1*	NORVAL et al. (2014a)
2007/06/25	Colubridae	*Amphiesma stolatum* (LINNAEUS, 1758)	F	401	22*	NORVAL et al. (2014a)
2007/09/21	Colubridae	*Amphiesma stolatum* (LINNAEUS, 1758)	F	451	1*	NORVAL et al. (2014a)
2007/09/21	Colubridae	*Lycodon rufozonatus* CANTOR, 1842	F	775	6*	NORVAL et al. (2014a)
2009/03/27	Colubridae	*Lycodon rufozonatus* CANTOR, 1842	M	351	1*	NORVAL et al. (2014a)
2008/06/30	Colubridae	*Sibynophis chinensis chinensis* (GÜNTHER, 1889)	M	327	1	NORVAL et al. (2008)
2002/06/07	Dactyloidae	*Anolis sagrei* DUMÉRIL & BIBRON, 1837	F	47	1	This note
2002/09/26	Dactyloidae	*Anolis sagrei* DUMÉRIL & BIBRON, 1837	M	55	2	This note
2002/11/21	Dactyloidae	*Anolis sagrei* DUMÉRIL & BIBRON, 1837	F	45	1	This note
2003/01/23	Dactyloidae	*Anolis sagrei* DUMÉRIL & BIBRON, 1837	M	50	1	This note
2007/06/17	Dactyloidae	*Anolis sagrei* DUMÉRIL & BIBRON, 1837	M	58	1	NORVAL et al. (2009)
2008/08/11	Scincidae	*Plestiodon elegans* (BOULENGER, 1887)	F	81	2*	NORVAL et al. (2014a)

tively, with an overall (i.e., the sexes combined) prevalence of 0.8 %. The parasites were unfortunately lost in the mail, but photographic records of the hosts and the parasites were subsequently deposited in the Zoological Reference Collection in the Lee Kong Chian Natural History Museum at the National University of Singapore (voucher numbers: *A. sagrei* – ZRC(IMG) 2.320 to ZRC(IMG) 2.323; and *K. pattoni* nymphs – ZRC(IMG) CRU.1 to ZRC(IMG) CRU.4). The photographic equipment used was a Nikon F60 35 mm AF SLR camera body fitted with an AF Micro-Nikkor 105 mm f/2.8 D lens.

Kiricephalus pattoni nymphs were collected on an ad hoc basis from *A. sagrei* and several other lizard and snake species from the same general locality as the specimens discussed herein (Table 1), but all were chance encounters or studies that did not systematically examine specimens. So, although the infection intensity could be reported in some instances, it was not possible to indicate the prevalence of these parasites.

The low prevalence of *K. pattoni* in *A. sagrei* from Santzepu suggests that infections by this parasite are uncommon in this lizard species. The fact that *K. pattoni* infections were not noted in *A. sagrei* from the same locality and reported on in NORVAL et al. (2011, 2014b) provides additional support for this conclusion.

The life cycle of *K. pattoni* is not fully understood, but RILEY & SELF (1980) stated that although it is not clear how the eggs of *K. pattoni* infect the first intermediate hosts, which are frogs and lizards, the second intermediate hosts and definitive hosts are snakes that prey upon frogs, lizards and other snakes, so it can be deduced that these infections most likely occur when these snakes consume infected prey. The results presented (Table 1) suggest that these parasites are present throughout the year, and that their life cycle is very likely not seasonal.

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REFERENCES: BUSH, A. O. & LAFFERTY, K. D. & LOTZ, J. M. & SHOSTAK, A. W. (1997): Parasitology meets ecology on its own terms: MARGOLIS et al. revisited.- Journal of Parasitology, Lawrence; 83 (4): 575-583. CHRISTOFFERSEN, M. L. & DE ASSIS, J. E. (2013): A systematic monograph of the recent Pentastomida with a compilation of their hosts.- Zoologische Mededelingen, Leiden; 87 (1): 1-206. NORVAL, G. & BURSEY, C. R. & GOLDBERG, S. R. & MAO, J. J. (2008): A record of *Kiricephalus pattoni* as a parasite of *Sibynophis chinensis chinensis* from Chiayi County, Taiwan.- Sauria, Berlin; 30 (4): 49-50. NORVAL, G. & BURSEY, C. R. & GOLDBERG, S. R. & MAO, J. J. & SLATER, K. (2011): Origin of the helminth community of an exotic invasive lizard, the brown anole, *Anolis sagrei* (Squamata: Polychrotidae), in southwestern Taiwan.- Pacific Science, Honululu; 65 (3): 383-390. NORVAL, G. & BURSEY, C. R. & GOLDBERG, S. R. & TUNG, C. L. & MAO, J. J. (2009): *Norops sagrei* (Brown anole) pathology and endoparasite. - Herpetological Bulletin, London; 107: 42-44. NORVAL, G. & GOLDBERG, S. R. & BURSEY, C. R. & MAO, J. J. (2014a): Notes on *Kiricephalus pattoni* nymphs, recorded as subcutaneous lumps in some squamates from the same locality in southwestern Taiwan, Republic of China.- Comparative Parasitology, Washington; 81 (1): 122-124. NORVAL, G. & GOLDBERG, S. R. & BURSEY, C. R. & MAO, J. J. & SLATER, K. (2014b): Internal parasites of lizards from Taiwan.- Herpetological Conservation and Biology, WWW online resource; 9 (3): 484-494 [available for download at < http://www.herpconbio.org/Volume_9/Issue_3/Norval_etal_2014.pdf >]. NORVAL, G. & HSIAO, W. F. & HUANG, S. C. & CHEN, C. K. (2010): The diet of an introduced lizard species, the brown anole (*Anolis sagrei*), in Chiayi County, Taiwan.- Russian Journal of Herpetology, Moskva; 17 (2): 131-138. RILEY, J. & SELF, T. J. (1980): On the systematics and life-cycle of the pentastomid genus *Kiricephalus* SAMBON, 1922, with descriptions of three new species.- Systematic Parasitology, Dordrecht; 1 (2): 127-140. RÓZSA, L. & REICZIGEL, J. & MAJOROS, G. (2000): Quantifying parasites in samples of hosts.- Journal of Parasitology, Lawrence; 86 (2): 228-232. SMALLRIDGE, C. J. & BULL, C. M. (2000): Prevalence and intensity of the blood parasite *Hemolivia mariae* in a field population of the skink *Tiliqua rugosa*.- Parasitology Research, Berlin; 86 (8): 655-660.

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