RESEARCH NOTES
НАУЧНЫЕ ЗАМЕТКИ

FIRST AMPHIBIAN BEHAVIOURAL OBSERVATION FROM THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA: PREDATION OF A *DRYOPHYTES JAPONICUS* TADPOLE BY *HYDATICUS* SP. LARVAE

Amaël Borzée

Ewha Womans University, Republic of Korea
e-mail: amaelborzee@gmail.com

Received: 03.09.2018. Revised: 06.11.2018. Accepted: 07.11.2018.

Data on the predator-prey relationship of small animal species is still understudied, especially in countries where scientific research is not yet widely shared, such as the Democratic People's Republic of Korea. Here, I report the interaction between a *Hydaticus* sp. larvae and a *Dryophytes japonicus* treefrog tadpole, where the invertebrate preyed on the vertebrate. This is the first data available on the diet of a *Hydaticus* sp. larvae, and the first behavioural observation of *D. japonicus*, in the Democratic People's Republic of Korea.

Key words: anuran, food web, Japanese treefrog, North Korea, predation

Amphibians play an important role in the food web, and very few individuals reach the adult stage (Cecil & Just, 1979). One of the main causes of mortality is predation by a wide variety of species (Wellborn et al., 1996; Kishida & Nishimura, 2005; Smith et al., 2005), mainly represented by fish and aquatic insects (e.g. Chivers & Mirza, 2001; Baber & Babbitt, 2004). Within aquatic insects feeding on tadpoles, a large body of research has been dedicated to dragonfly larvae (e.g. Caldwell et al., 1980), and their impact on tadpoles' behaviour and morphology (Relyea, 2001, 2003; Kishida & Nishimura, 2005). However, other species feed on amphibian larvae as well. For instance, adult individuals of *Hydaticus* sp. are selective bottom-foraging predatory diving beetles with a usual preference for *Chironomus* larvae as food item. However, they sometimes also include amphibian larvae to their diet (e.g. *Rana arvalis*, Nilsson 1842), although not as favourite preys (Klecka & Boukal, 2012; Culler et al., 2014).

The larvae of the Japanese Treefrog (*Dryophytes japonicus*, Günther 1859) display predator-specific behaviours, based on predator's foraging strategies (Takahara et al., 2006; Kim, 2016). These predators include for instance Goldfish (*Carassius auratus*, Linnaeus 1758), round-tailed paradise fish (*Macropodus ocellatus*, Cantor, 1842) and dragonfly nymphs (*Anax parthenope julius*, Brauer 1865 according to Takahara et al. (2006), and *Orthetrum albistylum*, Selys, 1848 according to Kim (2016)). The treefrog *D. japonicus* is widespread on the Korean Peninsula, both North (Kim & Han, 2009) and South (Roh et al., 2014) and it is therefore an important food item for predators (Tamada, 2012).

Here, I report a case of a *Hydaticus* sp. larvae preying on a *D. japonicus* tadpole (Fig.) in the Ramsar site Rason Migratory Bird Reserve in Rason in North Hamgyong, Democratic People's Republic of Korea (42.354604°N, 130.579742°E, 3 m a.s.l.) on 5 June 2018. The site was a shallow pond (approximately 10 × 7 m, 15–70 cm deep), resulting from soil extraction. The water quality was within the ecological requirements of the species at similar latitude (Hasumi et al., 2011; Heo et al., 2019; compared to Table). Only tadpoles of *D. japonicus* were found in the water despite the presence of numerous breeding *D. japonicus* and *Pelophylax nigromaculatus* at the site.

Fig. Predation on *Dryophytes japonicus* tadpole by a *Hydaticus* sp. larvae in Rason in the Democratic People's Republic of Korea in June 2018.

Table. Environmental variables at the observation site in Rason in the Democratic People's Republic of Korea in June 2018. These variables are not different from the ones at which *Dryophytes japonicus* is found in other parts of its range

Variables	Values
Air temperature (°C)	24.2
Relative humidity (%)	71
Air pressure (hPa)	17.8
Water temperature (°C)	29.2
Conductivity (μS)	85.5
pH	8.89
Salinity (ppm)	49.3
Total dissolved solids (ppm)	62.7

The predatory *Hydaticus* sp. larvae was likely to be *H. grammicus*, Germar 1827 (Yoon & Ahn 1988) based on the species abundance and distribution. It was seen grabbing the ventral area of the tadpole with its mandibles, before moving up towards the head (Fig.). The predator then proceeded to start feeding on the head of the tadpole through suction, while the tadpole swam, apparently to get rid of the predator. The anti-predator response was at first strong, but visibly weakening and ceased before the death of the tadpole within 10 minutes. Partial consumption of large food items, here missing head parts, is a described trait of a suctorial diving beetle such as *Hydaticus* sp. (Klecka & Boukal, 2013). To the best of our knowledge, this is the first report of a tadpole *D. japonicus* used as food sources by *Hydaticus* sp. larvae. It is also the first behavioural observation on an amphibian reported from the Democratic People's Republic of Korea (Kim & Han, 2009) and confirms the presence of both *D. japonicus* and *Hydaticus* sp. in the province.

Acknowledgements

I am grateful to the Hanns Seidel Foundation for supporting field work.

References

Baber M.J., Babbitt K.J. 2004. Influence of habitat complexity on predator-prey interactions between the fish (*Gambusia holbrooki*) and tadpoles of *Hyla squirella* and *Gastrophryne carolinensis*. *Copeia* 2004(1): 173–177. DOI: 10.1643/CE-03-056R1

Caldwell J.P., Thorp J.H., Jervey T.O. 1980. Predator-prey relationships among larval dragonflies, salamanders, and frogs. *Oecologia* 46(3): 285–289. DOI: 10.1007/BF00346253

Cecil S.G., Just J.J. 1979. Survival rate, population density and development of a naturally occurring anuran larvae (*Rana catesbeiana*). *Copeia* 1979(3): 447–453. DOI: 10.2307/1443221

Chivers D.P., Mirza R.S. 2001. Importance of predator diet cues in responses of larval wood frogs to fish and invertebrate predators. *Journal of Chemical Ecology* 27(1): 45–51. DOI: 10.1023/A:1005663815856

Culler L.E., Ohba S.-y., Crumrine P. 2014. Predator-prey interactions of dytiscids. In: D.A. Yee (Ed.): *Ecology, Systematics, and the Natural History of Predaceous Diving Beetles (Coleoptera: Dytiscidae)*. Dordrecht: Springer. P. 363–386. DOI: 10.1007/978-94-017-9109-0_8

Hasumi M., Hongorzul T., Terbish K. 2011. Animal species diversity at a land–water ecotone in Mongolia. *Limnology* 12(1): 37–45. DOI: 10.1007/s10201-010-0319-z

Heo K., Kim Y.I., Bae Y., Jang Y., Borzée A. 2019. First report of *Dryophytes japonicus* tadpoles in saline environment. *Russian Journal of Herpetology* 26.

Kim Y.E. 2016. *Differential antipredator behavior between Hyla japonica and H. suweonensis suggests separate evolution*. M.Sc. Thesis. Seoul: Ewha Womans University.

Kim L., Han G. 2009. *Chosun Animal Encyclopedia, Herpetology Volume*. Pyongyang, DPRK: Science and Technology Publisher.

Kishida O., Nishimura K. 2005. Multiple inducible defences against multiple predators in the anuran tadpole, *Rana pirica*. *Evolutionary Ecology Research* 7(4): 619–631.

Klecka J., Boukal D.S. 2012. Who eats whom in a pool? A comparative study of prey selectivity by predatory aquatic insects. *PloS ONE* 7(6): e37741.

Klecka J., Boukal D.S. 2013. Foraging and vulnerability traits modify predator–preybody mass allometry: freshwater macroinvertebratesas a case study. *Journal of Animal Ecology* 82(5): 1031–1041. DOI: 10.1111/1365-2656.12078

Relyea R.A. 2001. Morphological and behavioural plasticity of larval anurans in response to different predators. *Ecology* 82(2): 523–540. DOI: 10.1890/0012-9658(2001)082[0523:MABPOL]2.0.CO;2

Relyea R.A. 2003. Predators come and predators go: the reversibility of predator-induced traits. *Ecology* 84(7): 1840–1848. DOI: 10.1890/0012-9658(2003)084[1840:PCAPGT]2.0.CO;2

Roh G., Borzée A., Jang Y. 2014. Spatiotemporal distributions and habitat characteristics of the endangered treefrog, *Hyla suweonensis*, in relation to sympatric *H. japonica*. *Ecological Informatics* 24: 78–84. DOI: 10.1016/j.ecoinf.2014.07.009

Smith M.J., Drew M.M., Peebles M., Summers K. 2005. Predator cues during the egg stage affect larval development in the Gray Treefrog, *Hyla versicolor* (Anura: Hylidae). *Copeia* 2005(1): 169–173. DOI: 10.1643/CE-04-084R1

Takahara T., Kohmatsu Y., Maruyama A., Yamaoka R. 2006. Specific behavioral responses of *Hyla japonica t*adpoles to chemical cues released by two predator species. *Current Herpetology* 25(2): 65–70. DOI: 10.3105/1345-5834(2006)25[65:SBROHJ]2.0.CO;2

Tamada K. 2012. Seasonal change in habitat use by Grey Herons in a rural area of western Hokkaido. *Ornithological Science* 11(2): 95–102. DOI: 10.2326/osj.11.95

Wellborn G.A., Skelly D.K., Werner E.E. 1996. Mechanisms creating community structure across a freshwater habitat gradient. *Annual Review of Ecology and Systematics* 27: 337–363. DOI: 10.1146/annurev.ecolsys.27.1.337

Yoon I.B., Ahn K.J. 1988. A Systematic Study of Korean Dytiscidae III. – Colymbetinae and Dytiscinae. *Korean Journal of Entomology* 18(4): 251–268. [In Korean]

ПЕРВОЕ НАБЛЮДЕНИЕ ПОВЕДЕНИЯ АМФИБИИ ИЗ КОРЕЙСКОЙ НАРОДНО-ДЕМОКРАТИЧЕСКОЙ РЕСПУБЛИКИ: ХИЩНИЧЕСТВО ЛИЧИНКИ *HYDATICUS* SP. НА ГОЛОВАСТИКАХ *DRYOPHYTES JAPONICUS*

А. Борзи

Женский университет Ихва, Республика Корея
e-mail: amaelborzee@gmail.com

До сих пор существует недостаток данных о взаимодействиях хищника и жертвы среди мелких животных. Особенно в странах, где научные исследования еще широко не распространены, например, в Корейской Народно-Демократической Республике. В данной работе представлена информация о взаимодействии между личинкой *Hydaticus* sp. и головастиком квакши *Dryophytes japonicus*, где беспозвоночное животное охотилось на позвоночное. Это первые данные о рационе личинок *Hydaticus* sp. и первое наблюдение поведения *D. japonicus* в Корейской Народно-Демократической Республике.

Ключевые слова: бесхвостые, дальневосточная квакша, пищевая цепь, Северная Корея, хищничество