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Helminth parasites of the lemon-yellow tree frog, *Hyla savignyi* (Hylidae), from Turkey

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Abstract: Forty lemon-yellow tree frogs, *Hyla savignyi*, collected from Kırıkhan, Turkey (25 in April 2009, 15 in April 2010), were examined for helminths, and 21 frogs were found to be infected. One species of Monogenea (*Polystoma integerrimum*), 3 species of Digenea (*Diplodiscus subclavatus*, *Halipegus kessleri*, and *Pleurogenoides medians*), 1 species of Cestoda (*Nematotaenia dispar*), and 2 species of Nematoda (*Aplectana brumpti* and *Cosmocerca commutata*) were found.

Hyla savignyi represents a new host record for *Polystoma integerrimum*, *Diplodiscus subclavatus*, *Halipegus kessleri*, *Pleurogenoides medians*, *Aplectana brumpti*, and *Cosmocerca commutata*.

Key words: Monogenea, Digenea, Cestoda, Nematoda, lemon-yellow tree frog, *Hyla savignyi*, Turkey

Türkiye'den toplanan limon yeşili ağaç kurbağası (*Hyla savignyi*)'nın helmint parazitleri

Özet: Kırk tane limon yeşili ağaç kurbağası (*Hyla savignyi)* helmintleri için (25, Nisan 2009; 15, Nisan 2010), Kırıkhan'dan toplanmış ve incelenmiştir. Bunların 21 tanesinde parazit bulunmuştur. Bu parazitlerin biri Monogenea (*Polystoma integerrimum*), 3'ü Digenea (*Diplodiscus subclavatus*, *Halipegus kessleri*, *Pleurogenoides medians*), biri Cestoda (*Nematotaenia dispar*) ve ikisi Nematoda (*Aplectana brumpti*, *Cosmocerca commutata*)'ya aittir.

Hyla savignyi; *Polystoma integerrimum*, *Diplodiscus subclavatus*, *Halipegus kessleri*, *Pleurogenoides medians*, *Aplectana brumpti* ve *Cosmocerca commutata* için yeni konak kaydıdır.

Anahtar sözcükler: Monogen, Digen, Sestod, Nematod, limon yeşili ağaç kurbağası, *Hyla savignyi*, Türkiye

Introduction

The lemon-yellow tree frog, *Hyla savignyi* Audouin, 1827, is found in south-central Hadhramut in Saudi Arabia, northern Yemen, extreme northwestern Sinai, Israel, Syria, southern Turkey, northern and western Iran, Armenia, southern Georgia, and Azerbaijan (Frost, 2010). To our knowledge, there is just one report of helminths in *H. savignyi*; Al-Sorkhy and Amr (2003) reported an occurrence of *Nematotaenia dispar*. The purpose of this paper is to present a formal list of helminth species harbored by *H. savignyi*.

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Materials and methods

Forty lemon-yellow tree frogs (19 female and 21 male; mean snout-vent length [SVL]: 43 ± 3 mm, range: 37-50 mm) were collected by hand on 2 occasions at Kırıkhan, Turkey (36°27′50″N, 36°20′40″E; elevation of 90 m), on 12 April 2009 (25 individuals, 4 female and 21 male) and 12 April 2010 (15 individuals, all female). The frogs were examined within 1 week of capture. Each was euthanized with an overdose of sodium pentobarbital anesthetic and the body cavity was opened by making an incision from vent to throat. The abdominal cavity, stomach, intestine, heart, lungs, liver, urinary bladder, and mouth were examined separately for helminths using a dissecting microscope. Helminths were killed in a hot saline solution; nematodes were fixed in 70% ethanol and mounted in glycerol; and monogeneans, digeneans, and cestodes were fixed in 70% ethanol, stained with iron-carmine (Georgiev et al., 1986), cleared with clove oil, and mounted in Entellan® for examination with a compound microscope. Voucher specimens were deposited in the helminth collection of the Uludağ University Museum of Zoology, Bursa, Turkey. Frog specimens were deposited in the Department of Biology, Uludağ University, Bursa, Turkey. Anuran nomenclature follows that of Frost (2010).

Results

Polystoma integerrimum (Frölich, 1791) Rudolphi, 1808

Prevalence, mean intensity and range: Hosts infected, 2 of 40 (5%, 1.5 ± 0.7, 1-2).

Temporal distribution: April 2010, 2 hosts with 1 and 2, respectively.

Site of infection: Urinary bladder.

Additional Turkish hosts: None for *Polystoma integerrimum*, see remarks.

Type host and type locality: Common frog, *Rana temporaria*, Europe (Frölich, 1791).

Other reported hosts: Square-marked toad, *Amietophrynus regularis* (Ibrahim, 2008); common European toad, *Bufo bufo* (Kozák, 1969, 1973; Cox, 1971); natterjack toad, *Epidalea calamita* (Shimalov and Shimalov, 2001); pool frog, *Pelophylax lessonae* (André, 1913; Bovien, 1916; Kozák, 1968, 1969, 1973; Cox, 1971; Frandsen, 1974); European green toad, *Pseudepidalea viridis* (Kopriva, 1957; Buchvarov, 1965; Kozák, 1966, 1969, 1973; Skrjabin, 1979; Vashetko and Siddikov, 1999; Sey and Al-Ghaith, 2000; Al-Sorkhy and Amr, 2003; Saeed et al., 2007); moor frog, *Rana arvalis* (Kozák, 1969, 1973; Frandsen, 1974; Prokopic and Krivanec, 1975; Kuc and Sulgostowska, 1988a); spring frog, *Rana dalmatina* (Kozák, 1973); *Rana temporaria* (Frölich, 1791; André, 1913; Bovien, 1916; Baylis, 1928; Lees, 1962; Cox, 1971; Vojtková et al., 1963; Volna-Nabelkova, 1964; Kozák, 1966, 1969, 1973; Combes, 1968; Vojtková and Krivanec, 1970; Combes et al., 1971; Frandsen, 1974; Prokopic and Krivanec, 1975; Sattmann, 1986; Cedhagen, 1988; Kuc and Sulgostowska, 1988a).

Geographic range: Europe (Bentz et al., 2006), Iraq (Saeed et al., 2007), Jordan (Al-Sorkhy and Amr, 2003), Kuwait (Sey and Al-Ghaith, 2000), Uzbekistan (Vashetko and Siddikov, 1999).

Remarks: Three species of *Polystoma* have been reported from Turkey: *P. macrocnemis* Biserkov, Yıldırımhan, Buchvarov & Uğurtaş, 2001 in the Uludağ frog, *Rana macrocnemis*; *P. skrjabini* Buchvarov, 1984 in the European tree frog, *Hyla arborea*; and *P. viridis* Euzet, Combes & Batchvarov, 1974 in the European green toad, *Pseudepidalea viridis* (Yıldırımhan, 1999; Biserkov et al., 2001; Düşen and Öz, 2004). Euzet et al. (1974) assumed that each species of anuran harbored a distinct species of *Polystoma*. Given the number of host species recorded for *P. integerrimum*, a distinct species for each host species seems unlikely. Biserkov et al. (2001) found that *P. macrocnemis* and *P. viridis* were so closely related to *P. integerrimum* with respect to both geographical range and morphometric characteristics that separation is difficult if not impossible. We assigned the specimens of *Polystoma* found in Turkish hosts to *P. integerrimum*. *Hyla savignyi* represents a new host record for *Polystoma integerrimum*.

Gallien (1935) studied the general biology of *Polystoma integerrimum* and reported that the adults lay eggs only in the spring. These eggs give rise to larvae, which attach themselves to the gills of tadpoles and remain attached throughout the tadpole

metamorphosis, at which time the larvae migrate through the digestive tract to the urinary bladder.

***Diplodiscus subclavatus* (Pallas, 1760) Diesing, 1836**

Prevalence and intensity: Hosts infected, 1 of 40 (2.5%, 1).

Temporal distribution: April 2010, 1 host with 1.

Site of infection: Large intestine.

Additional Turkish hosts: *Rana dalmatina* (Düşen et al., 2009); marsh frog, *Pelophylax ridibundus* (Yıldırımhan et al., 1996, 2005; Düşen and Öz, 2006; Düşen et al., 2010).

Type host and type locality: *Rana* sp., Germany (Goeze, 1782).

Other reported hosts: European fire-bellied toad, *Bombina bombina* (Kopriva, 1957; Vojtková, 1961; Vojtková et al., 1963; Volna-Nabelkova, 1964; Kozák, 1966, 1969, 1973; Vojtková and Krivanec, 1970; Frandsen, 1974; Prokopic and Krivanec, 1975); yellow-bellied toad, *Bombina variegata* (Prokopic, 1957; Volna-Nabelkova, 1964; Kozák, 1966, 1969, 1973; Prokopic and Krivanec, 1975); *Bufo bufo* (André, 1912; Vojtková, 1961; Volna-Nabelkova, 1964; Cox, 1971; Kozák, 1973; Frandsen, 1974; Shimalov and Shimalov, 2001); European tree frog, *Hyla arborea* (Vojtková, 1961; Volna-Nabelkova, 1964); *Pelophylax lessonae* (André, 1913; Freund, 1933; Kopriva, 1957, Vojtková, 1961; Vojtková et al., 1963; Volna-Nabelkova, 1964; Kozák, 1966, 1968, 1969, 1973; Frandsen, 1974; Prokopic and Krivanec, 1975; Kuc and Sulgostowska, 1988a; Popovic and Mikes, 1989; Bjelic-Cabrilo, 2009); Iberian water frog, *Pelophylax perezi* (Navarro and Lluch, 2006); *Pelophylax ridibundus* (Buchvarov, 1962, 1965; Buchvarov et al., 1975; Bozkov, 1980; Kirin and Buchvarov, 2002; Kozák, 1966, 1969, 1973; Prokopic and Krivanec, 1975; Skrjabin, 1979; Popovic and Mikes, 1989); Sahara frog, *Pelophylax saharica* (Navarro and Lluch, 2006); *Pseudepidalea viridis* (Buchvarov, 1962; Vashetko and Siddikov, 1999); *Rana arvalis* (Prokopic, 1957; Volna-Nabelkova, 1964; Vojtková and Krivanec, 1970; Kozák, 1973; Frandsen, 1974; Prokopic and Krivanec, 1975); *Rana dalmatina* (Buchvarov, 1962; Volna-Nabelkova, 1964; Kozák, 1973; Düşen et al., 2009); *Rana temporaria* (Bovien, 1916; Baylis, 1928; Vojtková et al., 1963; Volna-Nabelkova, 1964; Kozák, 1966, 1973; Prokopic and Krivanec, 1975; Kuc and Sulgostowska, 1988a); alpine newt, *Ichthyosaura alpestris* (Barus et al., 1963; Vojtková and Vojtek, 1972); common newt, *Lissotriton vulgaris* (Taranko-Tulecka, 1959; Vojtková, 1963; Vojtková and Vojtek, 1972; Prokopic and Krivanec, 1975; Ryzhikov et al., 1980; Cedhagen, 1988; Bertman, 1994); northern crested newt, *Triturus cristatus* (Barus et al., 1963; Vojtková, 1963; Vojtková and Vojtek, 1972; Frandsen, 1974; Skrjabin, 1979; Bertman, 1994); sand lizard, *Lacerta agilis* (Lewin, 1992); European grass snake, *Natrix natrix* (Bertman, 1993; Shimalov and Shimalov, 2000); nose-horned viper, *Vipera berus* (Shimalov and Shimalov, 2000).

Geographic range: Europe (Yamaguti, 1958).

Remarks: *Hyla savignyi* represents a new host record for *Diplodiscus subclavatus*.

***Halipegus kessleri* (Grebnitzky, 1872) Wlassenko, 1929**

(Syn. *Distoma kessleri* Grebnitzky, 1872)

Prevalence and intensity: Hosts infected, 1 of 40 (2.55%, 3).

Temporal distribution: April 2010, 1 host with 3.

Site of infection: Stomach.

Additional Turkish hosts: None.

Type host and type locality: *Pelophylax lessonae*, Russia (Grebnitzky, 1872).

Other reported hosts: *Pelophylax lessonae* (Grebnitzky, 1872; Sey and Eory, 1992); *Pelophylax perezi* (Navarro and Lluch, 2006); *Pelophylax ridibundus* (Sey and Eory, 1992); northern crested newt, *Triturus cristatus* (Vojtková, 1963; Vojtková and Vojtek, 1972); common newt, *Lissotriton vulgaris* (Vojtková, 1963; Vojtková and Vojtek, 1972); *Natrix natrix* (Grebnitzky, 1872).

Geographic range: Europe (Yamaguti, 1958).

Remarks: Ingles (1936) considered *Halipegus kessleri* a variety of *Halipegus ovocaudatus*. *Hyla savignyi* represents a new host record for *Halipegus kessleri*. Turkey is a new locality record.

***Pleurogenoides medians* (Olsson, 1876) Travassos, 1921**

(Syn. *Distomum medians*, Olsson, 1878)

Prevalence, mean intensity, and range: Hosts infected, 14 of 40 (35%, 3.1 ± 2.9, 1-10).

Temporal distribution: April 2009, 13 hosts with 1, 1, 1, 1, 1, 1, 2, 3, 4, 4, 5, 8, and 10, respectively; April 2010, 1 host with 2.

Site of infection: Intestine.

Additional Turkish hosts: *Hyla arborea* (Düşen and Öz, 2004); *Pelophylax ridibundus* (Oğuz et al., 1994; Yıldırımhan et al., 1996, 2005; Düşen and Öz, 2006; Saglam and Arıkan, 2006; Düşen et al., 2010); *Rana dalmatina* (Düşen et al., 2009); Uludağ frog, *Rana macrocnemis* (Yildirimhan, Bursey et al., 2006; Düşen, 2007).

Type host and type locality: *Pseudepidalea viridis*, Denmark (Olsson, 1876).

Other reported hosts: *Bombina bombina* (Vojtková, 1961; Vojtková et al., 1963; Vojtková and Vojtek, 1975); yellow-bellied toad, *Bombina variegata* (Vojtková and Vojtek, 1975); *Bufo bufo* (Volna-Nabelkova, 1964; Cox, 1971; Kozák, 1973; Vojtková and Vojtek, 1975; Ryzhikov et al., 1980; Fernandez et al., 1987; Shimalov and Shimalov, 2001); *Epidalea calamita* (Vojtková and Vojtek, 1975); *Hyla arborea* (Kozák, 1969, 1973; Vojtková and Vojtek, 1975; Ryzhikov et al., 1980); common Eurasian spadefoot toad, *Pelobates fuscus* (Ryzhikov et al., 1980); *Pelophylax lessonae* (André, 1913; Bovien, 1916; Odening, 1957; Kopriva, 1957; Vojtková, 1961; Vojtková et al., 1963; Volna-Nabelkova, 1964; Kozák, 1966, 1968, 1969, 1973; Combes et al., 1973; Vojtková and Vojtek, 1975; Buchvarov, 1977; Ryzhikov et al., 1980; Kuc and Sulgostowska, 1988a; Popovic and Mikes, 1989; Bjelic-Cabrilo et al., 2009); *Pelophylax ridibundus* (Buchvarov, 1962, 1977, 1983; Combes and Gerbeaux, 1970; Cox, 1971; Kozák, 1973; Ryzhikov et al., 1980; Kuc and Sulgostowska, 1988b; Popovic and Mikes, 1989; Saeed et al., 2007); *Pseudepidalea viridis* (Kolendo, 1959; Vojtková and Vojtek, 1975; Ryzhikov et al., 1980); *Rana amurensis* (Ryzhikov et al., 1980); *Rana arvalis* (Volna-Nabelkova, 1964; Kozák, 1973; Vojtková and Vojtek, 1975; Ryzhikov et al., 1980); *Rana dalmatina* (Kozák, 1973; Prokopic and Krivanec, 1975; Buchvarov, 1977; Düşen et al., 2009); Balkan stream frog, *Rana graeca* (Buchvarov, 1982); *Rana temporaria* (Bovien, 1916; Kopriva, 1957; Vojtková and Krivanec, 1970; Prokopic and Krivanec, 1975; Vojtková and Vojtek, 1975; Ryzhikov et al., 1980; Cedhagen, 1988); *Lissotriton vulgaris* (Vojtková, 1963; Vojtková and Vojtek, 1972; Ryzhikov et al., 1980); *Triturus cristatus* (Vojtková, 1963; Vojtková and Vojtek, 1972); *Lacerta agilis* (Lewin, 1992; Sharpilo et al., 2001); Iberian wall lizard, *Podarcis hispanica* (Roca et al., 1986; Roca and Lluch, 1988).

Geographic range: Western Europe (Yamaguti, 1971).

Remarks: *Hyla savignyi* represents a new host record for *P. medians*.

Cestoda

***Nematotaenia dispar* (Goeze, 1782) Lühe 1899**

(Syn. *Taenia dispar* Goeze, 1782; *Taenia dispar salamandrae* Frölich, 1789; *Taenia bufonis* Gmelin, 1790; *Halysis obvoluta* Zeder, 1803; *Nematotaenia kashmirensis* Fotedar, 1966; *Nematotaenia dollfusi* Yuen and Fernando, 1974; *Nematotaenia viride* Mokhtar-Maamouri & Chakroun, 1984)

Prevalence and intensity: Hosts infected, 3 of 40 (7.5%, 2.3 ± 0.6, 2-3).

Temporal distribution: April 2010, 3 hosts with 2, 2, and 3, respectively.

Site of infection: Small intestine.

Additional Turkish hosts: *Pseudepidalea viridis* (Yıldırımhan, 1999; Düşen et al., 2010); *Rana macrocnemis* (reported as *R. camerani*; Yıldırımhan, Goldberg et al., 2006); Caucasian salamander, *Mertensiella caucasica* (Yıldırımhan et al., 2005).

Type host and type locality: Undetermined toad, Germany (Goeze, 1782).

Other reported hosts: **Oriental Realm:** Asian black-spotted toad, *Duttaphrynus melanostictus* (Southwell, 1922; Yuen and Fernando, 1974; Jones, 1987). **Palaearctic Realm:** Madagascar jumping frog, *Aglyptodactylus madagascariensis* (Meggitt, 1928); Moroccan toad, *Amietophrynus mauritanicus* (Joyeux, 1923; Joyeux and Gaud, 1945; Dollfus, 1957); Egyptian toad, *Amietophrynus regularis* (Rysavy et al., 1974; Jones, 1987; Ibrahim, 2008);

Bombina bombina (Buchvarov, 1977); *Bombina variegata* (Prokopic, 1957; Buchvarov, 1963; Hristovski and Riggio, 1971; Prokopic and Krivanec, 1975; Ryzhikov et al., 1980); *Bufo bufo* (Zeder, 1803; Rudolphi, 1810, 1819; Schmidt, 1855; Polonio, 1859; Parona, 1894; Molin, 1861; Fuhrmann, 1895; Lühe, 1910; André, 1912; Baylis, 1928; Joyeux and Baer, 1936; Lopez-Neyra, 1944; Gässlein, 1954; Capuse and Dancau, 1957; Dollfus, 1957, 1961; Elkan, 1960; Volna-Nabelkova, 1964; Löser, 1965; Cox, 1971; Hristovski and Riggio, 1971; Jones, 1987); Arabian toad, *Duttaphrynus arabicus* (Kuntz and Myers, 1968); *Epidalea calamita* (Gässlein, 1954; Dollfus, 1957; Fernandez et al., 1987); *Hyla arborea* (Rudolphi, 1819; Bremser, 1824; Dujardin, 1845; Giebel, 1866; Lopez-Neyra, 1944; Sandner, 1949; Gässlein, 1954; Capuse and Dancau, 1957; Volgar-Pastukhova, 1959; Volna-Nabelkova, 1964; Grabda-Kazubska, 1972; Hristovski and Riggio, 1974; Al-Barwari and Nassir, 1983; Jones, 1987; Vashetko and Siddikov, 1999; Saeed et al, 2007); stripeless tree frog, *Hyla meridionalis* (Jones, 1987); Savigny's tree frog, *Hyla savignyi* (Al-Sorkhy and Amr, 2003); *Pelobates fuscus* (Rudolphi, 1819; Dujardin, 1845; Lühe, 1910; Mazurmovich, 1951; Gässlein, 1954; Volgar-Pastukhova, 1959; Ryzhikov et al., 1980); Levant green frog, *Pelophylax bedriagae* (Al-Sorkhy and Amr, 2003); *Pelophylax lessonae* (Fuhrmann, 1926; Joyeux and Baer, 1936; Lopez-Neyra, 1944; Kozák, 1968; Cox, 1971; Prokopic and Krivanec, 1975); *Pelophylax ridibundus* (Mazurmovich, 1951; Prokopic, 1957; Volgar-Pastukhova, 1959; Buchvarov, 1963, 1965, 1970; Bozkov, 1965a; Prokopic and Krivanec, 1975; Babaev and Annakulieva, 1978); Iranian toad, *Pseudepidalea surda* (Dollfus, 1965); *Pseudepidalea viridis* (Batsch, 1786; Rudolphi, 1810, 1819; Polonio, 1859; Parona, 1894; Lühe, 1910; Issaitschikov, 1922; Volgar-Pastukhova, 1959; Ricci, 1960; Korai, 1961; Buchvarov, 1963, 1965; Volna-Nabelkova, 1964; Bozkov, 1965b; Fotedar, 1966; Hristovski and Riggio, 1971; Rysavy et al., 1974; Buchvarov et al., 1975; Babaev and Annakulieva, 1978; Al-Barwari and Nassir, 1983; Mokhtar-Maamouri and Chakroun, 1984; Jones, 1987; Vashetko and Siddikov, 1999; Sey and Al-Ghaith, 2000; Al-Sorkhy and Amr, 2003); Mascarene grassland frog, *Ptychadena mascareniensis* (Walton, 1939); *Rana dalmatina* (Joyeux and Baer, 1936; Jones, 1987); Iberian frog, *Rana iberica* (Combes and Knoepffler, 1966); *Rana macrocnemis* (Dinnik, 1926; Kalabekov, 1973); *Rana temporaria* (Diesing, 1854; Schmidt, 1855; Lühe, 1910; Baylis, 1928; Rémy, 1943; Conde and Husson, 1946; Buchvarov, 1970; Cox, 1971; Hristovski and Lees, 1973; Jones, 1987); alpine salamander, *Salamandra atra* (Frölich, 1789; Schmidt, 1855; Lühe, 1910; Fuhrmann, 1926); alpine newt, *Ichthyosaura alpestris* (Walton, 1964); *Salamandra salamandra* (Walton, 1939); *Darevskia lindholmi* (Goldin, 1975); desert monitor, *Varanus griseus* (Dollfus, 1965, Al-Mohammed, 2009). **Nearctic Realm:** Southern cricket frog, *Acris gryllus* (Walton, 1939); American toad, *Anaxyrus americanus* (Leidy, 1855); southern toad, *Anaxyrus terrestris* (Walton, 1939); Colorado River toad, *Incilius alvarius* (Goldberg and Bursey, 1991); Sinaloa toad, *Incilius mazatlanensis* (Goldberg and Bursey, 2002); northern leopard frog, *Lithobates pipiens* (Leidy, 1855; Wright, 1879); cane toad, *Rhinella marina* (Goldberg et al., 2002); mudpuppy, *Necturus maculosus* (Leidy, 1855).

Geographic range: Oriental, Nearctic, and Palaearctic realms (Jones, 1987).

Remarks: This is the second report of *Nematotaenia dispar* in *Hyla savignyi*.

Nematoda

***Aplectana brumpti* Travassos, 1931**

(Syn: *Aplectana miranda* Ivanitzky, 1940; *Aplectana corti* Lopez-Neyra, 1947; *Aplectana ivanitzkyi* Markov, Khonyakina & Grivor'eva 1972)

Prevalence and intensity: Hosts infected, 1 of 40 (2.5%, 1).

Temporal distribution: April 2009, 1 host with 1.

Site of infection: Large intestine.

Additional Turkish hosts: *Pseudepidalea viridis* (Schad et al., 1960); *Pelobates syriacus* (Schad et al., 1960); Caucasian parsley frog, *Pelodytes caucasicus* (Yıldırımhan et al., 2009).

Type host and type locality: *Pseudepidalea viridis*, Corsica, Spain (Travassos, 1931).

Other reported hosts: *Bufo bufo* (Fernández et al., 1987); natterjack toad, *Epidalea calamita* (Fernández et al., 1987); *Pelophylax ridibundus* (Ivanitzky, 1940); *Pseudepidalea viridis* (Travassos, 1931; Lopez-Neyra,

1947; Kozlowska, 1960; Kozák, 1969; Frandsen, 1974; Baker, 1980); *Rana temporaria* (Ivanitzky, 1940); grass snake, *Natrix natrix* (Markov et al. 1962; Sharpilo, 1976); dice snake, *Natrix tessellata* (Markov et al., 1962; Sharpilo, 1976).

Geographic range: Western Europe (Baker, 1980).

Remarks: Females produce eggs that larvate in utero before being released to the environment where hatching occurs; the final host becomes infected orally (Anderson, 2000). *Hyla savignyi* represents a new host record for *Aplectana brumpti*.

***Cosmocerca commutata* (Diesing, 1851) Diesing 1861**

(Syn: *Cosmocerca pulherima* Ivanitzky, 1940; *Cosmocerca skrjabini* Ivanitzky, 1940; *Cosmocerca timofejevoi* Skarbilovich, 1950; *Cosmocerca kashmirensis* Fotedar, 1959)

Prevalence and intensity: Hosts infected, 1 of 40 (2.5%, 1).

Temporal distribution: April 2009, 1 host with 1.

Site of infection: Large intestine.

Additional Turkish hosts: European tree frog, *Hyla arborea* (Düşen and Öz, 2004); marsh frog, *Pelophylax ridibundus* (Düşen and Öz, 2006); European green toad, *Pseudepidalea viridis* (Schad et al., 1960; Yıldırımhan, 1999; Yıldırımhan and Karadeniz, 2007); Anatolia newt, *Neurergus strauchii* (Yıldırımhan et al., 2004; Yıldırımhan, 2007).

Type host and type locality: *Pseudepidalea viridis*, western Europe (Diesing, 1851).

Other reported hosts: European fire-bellied toad, *Bombina bombina* (Volna-Nabelkova, 1964; Kozák, 1969, 1973; Moravec and Vojtková, 1974; Vojtková, 1976); yellow-bellied toad, *Bombina variegata* (Prokopic and Krivanec, 1975; Vojtková, 1976); *Bufo bufo* (Diesing, 1851; Volna-Nabelkova, 1964; Kozák, 1969, 1973; Moravec and Vojtková, 1974; Vojtková, 1976; Grabda-Kazubska and Tenora, 1991); natterjack toad, *Epidalea calamita* (Frandsen, 1974); *Hyla arborea* (Volna-Nabelkova, 1964; Moravec and Vojtková, 1974; Vojtková, 1976); edible frog, *Pelophylax lessonae* (Kozák, 1968, 1969, 1973; Moravec and Vojtková, 1974; Vojtková, 1976); marsh frog, *Pelophylax ridibundus* (Buchvarov, 1965; Buchvarov et al., 1975; Babaev and Annakulieva, 1978; Saeed et al., 2007); *Pseudepidalea viridis* (Ivanitzky, 1940; Fotedar, 1959; Kozlowska, 1960; Vojtková, 1961; Volna-Nabelkova, 1964; Buchvarov, 1965; Kozák, 1969, 1973; Hristovski, 1973; Frandsen, 1974; Moravec and Vojtková, 1974; Buchvarov et al., 1975; Prokopic and Krivanec, 1975; Vojtková, 1976; Vashetko and Siddikov, 1999); moor frog, *Rana arvalis* (Prokopic, 1957; Volna-Nabelkova, 1964; Moravec and Vojtková, 1974; Vojtková, 1976); agile frog, *Rana dalmatina* (Hristovski, 1973; Kozák, 1973; Buchvarov et al., 1975; Vojtková, 1976); *Rana temporaria* (Ivanitzky, 1940; Volna-Nabelkova, 1964; Kozák, 1969, 1973; Moravec and Vojtková, 1974; Vojtková, 1976; Sattmann, 1986); European fire salamander, *Salamandra salamandra* (Vojtková, 1963).

Geographic range: Europe, India (Baker, 1987).

Remarks: *Hyla savignyi* represents a new host record for *C. commutata*.

Discussion

In all, 60 helminths were collected from 21 (53%) of the 40 tree frogs examined. Seven helminth species were found: 1 species of monogeneans (N = 3), 3 species of digeneans (N = 48), 1 species of cestodes (N = 7), and 2 species of nematodes (N = 2). No individual host harbored more than 2 species of helminths. Of the infected tree frogs, 19 (90%) harbored 1 species of helminth and 2 (10%) harbored 2 species. There were 1.10 ± 0.07 (X ± 1 SE) (range: 1-2) helminth species per infected tree frog and 2.86 ± 0.52 (range: 1-10) helminth individuals per infected tree frog. Aho (1990) compiled distributional patterns for anurans in general and reported the total number (mean ± SE) of helminth species per host species as 3.54 ± 0.24 (range: 0-9). Thus, the infection rates for *H. savignyi* are much lower than for anurans in general. Determining whether the hot, terrestrial habitat of *H. savignyi* is responsible for this difference will require additional work.

Sixteen species of anurans occur in Turkey (Frost, 2010). These are Bombinatoridae: *Bombina bombina* (Linnaeus, 1761); Bufonidae: *Bufo bufo* (Linnaeus, 1758), *Bufo verrucosissimus* (Pallas, 1814), *Pseudepidalea variabilis* (Pallas, 1769); Hylidae: *Hyla orientalis* Bedriaga, 1890, *Hyla savignyi* (Audouin,

1827); Pelobatidae: *Pelobates fuscus* (Laurenti, 1768), *Pelobates syriacus* (Boettger, 1889); Pelodytidae: *Pelodytes caucasicus* Boulenger, 1896; Ranidae: *Pelophylax bedriagae* (Camerano, 1882), *Pelophylax caralitanus* (Arıkan, 1988), *Pelophylax ridibundus* (Pallas, 1771), *Rana dalmatina* Fitzinger, 1839, *Rana graeca* Boulenger, 1891, *Rana macrocnemis* Boulenger, 1885, *Rana tavasensis* Baran and Atatur, 1986. To our knowledge, Turkish populations of *Bufo verrucosissimus*, *Pelobates fuscus*, *Pelophylax bedriagae*, *Pelophylax caralitanus*, *Rana graeca*, and *Rana tavasensis* have not been examined for helminths. Taxonomic reassignment has made parasite host lists problematic: Stöck et al. (2006) removed *Pseudepidalea variabilis* from the synonymy of *Pseudepidalea viridis*, while Frost (2010) assigned Turkish populations to *P. variabilis* but suggested that the situation between *P. variabilis* and *P. viridis* is not clear. Stöck et al. (2008) removed *Hyla orientalis* from the synonymy of *Hyla arborea*, and Frost (2010) assigned the Turkish populations to *H. orientalis*.

We have adjusted the parasite lists (Table) to reflect current anuran taxonomy. It is of interest to note that the nematodes commonly infecting Turkish anurans, namely *Aplectana brumpti*, *Cosmocerca ornata*, *Oswaldocruzia filiformis*, *Oxysomatium brevicaudatum*, and *Rhabdias bufonis*, directly infect the host (Anderson, 2000). Thus, for nematodes, habitat is more important than diet in determining rates of infection. Acanthocephalans require at least 2 hosts in the life cycle; arthropods are the usual intermediate hosts in which the infective stage develops, and when eaten by an appropriate final host, the parasite develops to maturity in the digestive tract (Nickol, 1985). Species of *Polystoma* infect directly (Gallien, 1935). The digeneans generally utilize either a molluscan first intermediate host from which the cercariae leave and penetrate a frog host directly, or a variety of invertebrate hosts, which are then eaten by the final host (Symth and Symth, 1980). The conclusion that we draw is that generalist helminths infect Turkish anurans and may vary within a particular host over time and space, as seen in the Table. However, within its population of hosts, a helminth species is persistent. We predict that as more subpopulations of these hosts are studied, parasite lists will become more similar.

Table. Reported helminths of Turkish anurans.

	Bombina bombina	*Bufo bufo*	*Hyla orientalis*	*Hyla savignyi*	*Pelobates syriacus*	*Pelodytes caucasius*	*Pelophylax ridibundus*	*Pseudepidalea variabilis*	*Rana dalmatina*	*Rana macrocnemis*
Monogenea										
Polystoma sp.	–	–	–	–	8	–	–	–	23	24, 26
Polystoma integerrimum	–	–	–	7	–	–	–	–	–	25, 27
Polystoma macrocnemis	–	–	–	–	–	–	–	–	–	–
Polystoma skrjabini	–	–	5, 6	–	–	–	–	–	–	–
Polystoma viridis	–	–	–	–	–	–	–	22, 33	–	–
Digenea										
Brachycoelium salamandrae	–	–	–	–	–	–	10, 33	–	–	
Bucephalus polymorphis	–	–	–	–	–	–	11	–	–	–
Candidotrema loossi	–	–	–	–	–	–	12	–	–	–
Diplodiscus sp.	–	–	–	–	–	–	14	–	–	–
Diplodiscus subclavatus	–	–	–	7	–	–	15, 33	–	23	–
Gorgodera sp.	–	–	–	–	–	–	14	–	–	–
Gorgodera cygnoides	–	–	–	–	–	9	10,12,13, 33	–	–	24
Gorgoderina sp.	–	–	–	–	–	–	14	–	–	–
Gorgoderina vitelliloba	–	–	–	–	–	–	16, 33	–	–	24,25,26
Haematoloechus breviansa	–	–	–	–	–	–	10,12,13	–	–	–
Haematoloechus variegatus	–	–	–	–	–	–	12, 17	–	–	–
Halipegus kessleri	–	–	–	7	–	–	–	–	–	–
Haplometra cylindracea	–	–	–	–	–	–	–	–	–	24, 25, 28
Opisthioglyphe ranae	1	–	–	–	–	–	10,12,13	–	–	–

Table. Continued.

	Bombina bombina	*Bufo bufo*	*Hyla orientalis*	*Hyla savignyi*	*Pelobates syriacus*	*Pelodytes caucasius*	*Pelophylax ridibundus*	*Pseudepidalea variabilis*	*Rana dalmatina*	*Rana macrocnemis*
Opisthioglyphe rastellus	–	–	–	–	–	–	–	–	–	24, 25, 28
Plagiorchis sp.	–	–	–	–	–	–	14	–	–	–
Pleurogenes claviger	–	–	–	–	–	–	12, 18	–	23	25, 26
Pleurogenoides medians	–	–	5	7	–	–	19, 33	33	23	24, 25, 28
Pleurogenoides stromi	–	–	–	–	–	–	13	–	–	–
Prosotocus confusus	–	–	–	–	–	–	10,12,13	–	–	–
Rauschiella sp.	–	–	–	–	–	–	12	–	–	–
Encyclometra colubrimurorum (metacercariae)	–	–	5	–	–	–	10	–	–	–
Codonocephalus urniger (metacercariae)	–	–	–	–	–	–	10,12,13	–	–	–
Cestoda										
Nematotaenia dispar	–	–	–	7	–	–	–	22, 33	–	24
Proteocephalus sp. (juvenile)	–	–	5	–	–	–	–	22	–	–
Nematoda										
Agfa tauricus	–	–	–	–	–	9	–	–	–	–
Aplectana acuminata	–	3	–	–	–	–	–	–	–	–
Aplectana brumpti	–	–	–	7	3, 8	9	–	4	–	–
Aplectana macintoshii	–	3, 4	–	–	–	–	–	–	–	–
Cosmocerca sp.	1	–	–	–	–	–	2, 12, 14	–	–	26
Cosmocerca ornata	–	3, 33	6	–	–	9	4, 13, 33	4, 33	23	29
Cosmocerca commutata	–	–	5	7	–	–	10	4, 22	–	–
Cosmocercoides sp.	–	–	–	–	–	–	17	22	–	–
Oswaldocruzia sp.	–	2	–	–	–	–	12	4	–	–
Oswaldocruzia filiformis	–	3, 4	6	–	–	9	13, 17	22, 33	23	30
Oxysomatium brevicaudatum	–	2, 4, 33	–	–	2, 8	–	4, 13, 17, 33	4, 22, 33	23	4
Oxysomatium sp.	–	–	–	–	–	–	10	–	–	–
Rhabdias sp.	–	–	–	–	–	–	–	4	–	4
Rhabdias bufonis	1	2, 3	–	–	–	9	20	22	23	24, 25
Skrjabinelazia taurica	–	–	–	–	8	–	–	–	–	–
Abbreviata sp. (larvae)	–	–	–	–	–	–	10	–	–	–
Eustrongylides excisus (larvae)	–	–	–	–	–	–	13, 17	–	–	–
Eustrongylides sp. (larvae)	–	–	–	–	–	–	10	–	–	–
Acanthocephala										
Acantocephalus sp.	–	–	–	–	–	–	14	–	–	–
Acantocephalus ranae	1	3	5	–	–	–	21	22	23	31
Centrorhynchus sp.	–	–	–	–	–	–	13, 17	–	–	–
Pomphorhynchus laevis	–	–	–	–	–	–	32	–	–	–
Pseudoacanthocephalus caucasicus	–	–	–	–	–	9	–	–	–	–

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