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The caddisflies (Trichoptera) of springs in the Roztocze region (south-eastern Poland)

Chruściki (Trichoptera) źródeł Roztocza (południowo-wschodnia Polska)

SUMMARY

Studies on caddisflies (Trichoptera) of springs of the Roztocze region in south-eastern Poland were conducted in 2002–2006. They covered 21 study sites of two types – 6 valley-springs and 15 valley-side springs. During the studies 1927 specimens representing 39 species were recorded in general. 7 species were new to the fauna of lowland and upland springs in Poland. The paper gives the detailed analysis of caddisfly fauna of the springs in Roztocze, the comparison between the faunas inhabiting two different types of springs, as well as characteristics of the most naturally valuable study sites due to specific species composition, the presence of red-listed and protected species.

STRESZCZENIE

Badania nad chruścikami (Trichoptera) źródeł Roztocza w południowo-wschodniej Polsce przeprowadzone były w latach 2002–2006. Objęły one 21 stanowisk dwu typów – 6 źródeł dolinnych i 15 źródeł podzboczowych. Podczas badań odłowiono 1927 osobników należących do 39 gatunków. Siedem gatunków stwierdzono po raz pierwszy w źródłach Polski niżowej i wyżowej. W pracy przedstawiono szczegółową analizę fauny chruścików źródeł Roztocza, porównanie fauny zasiedlającej dwa odmienne typy źródeł oraz charakterystykę najcenniejszych przyrodniczo stanowisk ze względu na specyficzny skład gatunkowy i obecność gatunków z Czerwonej listy, a także pojedynczego objętego ochroną gatunkową.

K e y w o r d s: caddisflies, Roztocze, valley springs, valley-side springs, Red list

INTRODUCTION

Caddisflies (Trichoptera) inhabiting springs comprise the largest group of macrozoobenthos of such habitats. However, they are still poorly studied in Poland, especially, this refers to caddisflies of lowland and upland areas. Moreover, data on aquatic stages of spring caddisflies very often appears as an element of general analysis of trichopteral fauna of a larger area.

In 1999 Czachorowski published the synthetic paper about the caddisfly of springs in Poland (8) in which he made the conclusion that caddisfly faunas in particular regions of the country are very diversified, even within lowlands, uplands or mountains themselves. Therefore, the completing the knowledge on spring caddisflies of the geographical units of higher level, especially lowland and highland ones, is still necessary and important.

Roztocze belongs to one of the richest areas in spring habitats in Poland, however, this type of habitat has not been the object of the detailed or separated studies with respect to Trichoptera so far. Single data about caddisflies of this region can only be found in the paper of Riedel and Majecki (14).

The main aims of the work were as follows: the investigation of the caddisfly fauna of springs in Roztocze as the contribution to the general picture of already known species and assemblages of lowland and upland springs in Poland, comparing the faunas inhabiting two different types of springs in Roztocze – valley and valley-side ones, as well as pointing out the most naturally valuable sites for caddisfly development due to specific species composition or the presence of red-listed or protected species.

STUDY AREA AND METHODS

Roztocze is a region which forms the range of elevations separating two river systems: one of the river Wieprz and Bug from the northern-east and the second of the river San and Dniestr from the southern-west. The range joins the Lublin Upland and Podole. Its hydrographic net is poorly dense due to high ground permeability (5). There are active 284 springs in Polish part of Roztocze. They are situated very irregularly and have different capacity (13).

The studies were conducted in the years 2002–2006 within 21 springs situated in river valleys or associated with small tributaries of those rivers (Fig. 1). The springs of the river Wieprz were in: Wieprzów Tarnawacki (no. 20 – Fig. 1, 2 and Tab.), Szczebrzeszyn (6), Wywłoczka (7), Stokowa Mountain near Guciów (8), Hutki (13), Dąbrowa Tarnawacka (19); the river Biała Łada – Malinie (1), Goraj (2), Stara Wieś (3); the river Sopot – Husiny (14), Ciotusza (15), Nowiny (16); the river Krupiec – Józefów Roztoczański (10, 11); the river Tanew – Dębiny (21); the river Niepryszka – Józefów Roztoczański (9); the river Por – Zaporze (5). The remaining springs were situated in: Podlesie (4) within a pond complex, Susiec ("Morskie Oko" pond) (17), in the ecological ground "Belfont" near Hutki (12) and in Zawadki (18) – a spring of small tributary of the river Olszanka.

In this paper the division of springs on account of their morphology is taken after Michalczyk (13). Therefore, all study sites belonged to one of two categories: valley springs – 6 study sites (no. 1, 5, 12, 17, 19, 20) – formed in shape of water body, quite deep, with well developed shore and aquatic vegetation, with the bottom of sand and in many cases – with thick layer of detritus; valley-side springs – 15 study sites (the rest ones) – shallow ones, bottom of stones and gravel, vegetation poorly developed – in some cases *Berula erecta* Huds. (Cov.) only.

Aquatic stages of caddisflies were collected with the use of hydrobiological scoop (in both types of springs) and picked up by hands from submersed stones, branches or plants (mainly in valley-side type). Samples were taken regularly once in two-month periods from March till Octo-

ber in order not to destroy vulnerable fauna. Additionally, imagines occurring on adjacent plants, trees, rocks were also collected, however, they were rarely found.

In the analysis of collected material the following ecologic indexes were used: classes of dominance after Biesiadka (2), quantitative faunistic similarities according to Biesiadka's formula (1) and qualitative and quantitative biocenosis naturality indexes (Wns, Wni) for springs in modification of Czachorowski (8).

RESULTS

During the studies 1927 specimens representing 39 species were recorded in total (Tab.). *Allogamus auricollis*, *Limnephilus germanus*, *L. luridus*, *L. sparsus*, *Sericostoma schneideri* and *Trichostegia minor* have been found for the first time in springs of lowlands and uplands in Poland. *Anabolia laevis* recorded during the studies in form of pupae and imagines should also be added to this list because larval specimens found in springs during earlier researches (8, 15) were identified to the level of the genus only (it might have been *Anabolia furcata* or *A. laevis* as well).

To the species with the widest habitat spectrum belonged: *Chaetopteryx villosa* that occurred in 13 from 21 study sites, *Limnephilus lunatus* (11 study sites), *Plectrocnemia conspersa* (10), *Apatania muliebris* (7), *Potamophylax nigriconis* (6) and *Sericostoma personatum* (6).

The highest number of species was found at study sites number: 21 (14 species), 11 (13), 9 (10), 12 (9) – at the remaining sites the number of species was lower and ranged from 1 to 6 species. As for the number of specimens the same study sites were the most crucial – study site 9 (383 specimens), 21 (357), 12 (231), 11 (226), moreover – the study site 14 with 211 specimens represented by 5 species. Except for the study site 12 which was a valley spring type, the study sites mentioned above belonged to valley-side springs.

In the structure of dominance the following species belonged to the class of eudominants: *Chaetopteryx villosa*, *Apatania muliebris* and *Limnephilus lunatus*, to the class of dominants – *Potamophylax nigricornis* and *Sericostoma personatum*, the most numerous was the class of subdominants with *Plectrocnemia conspersa*, *Rhyacophila nubila*, *R. fasciata*, *Allogamus auricollis* and *Limnephilus extricatus* in it. The remaining species belonged to recedents (Tab.).

While comparing in detail faunas of two types of springs, 340 specimens representing 21 species were found in the examined valley springs, in valley-side ones – respectively – 1587 specimens with 28 species. The classes of dominance in both spring types varied in large part. The class of eudominants was represented in valley springs by *Limnephilus lunatus* only (almost 60%) – eurytopic and crenoxene species inhabiting open areas. In valley-side springs to that

Table. List of caddisflies (Trichoptera) recorded in the springs of the Roztocze region. VS – valley spring, VSS – valley-side spring, D – dominance, N – specimen number. Numbering of study sites like in the text

No.	**Species/Taxon**	VS	VSS	D	N	Number of study sites
1.	*Rhyacophila fasciata* Hag.		●	3,3	64	11,14,21
2.	*R. nubila* (Zett.)		●	3,8	74	9,21
3.	*Plectrocnemia conspersa* (Curt.)	●	●	3,9	77	1,2, 3,8,10,11,16,18,21,
4.	*Lype phaeopa* (Steph.)		●	0,05	1	21
5.	*Hydropsyche instabilis* (Curt.)		●	0,20	4	21
6.	*H. pellucidula* (Curt.)		●	0,10	2	8
7.	*Oligotricha striata* (L.)		●	0,46	9	11
8.	*Trichostegia minor* (Curt.)	●	●	0,25	5	11,19
9.	*Phryganea bipunctata* Retz.	●		0,05	1	17
10.	*Phryganea grandis* L.	●		0,05	1	17
11.	*Crunoecia irrorata* (Curt.)		●	0,31	6	10,11,21
12.	*Apatania muliebris* McL.	●	●	17,5	338	1,2,9,11,14,18,21
13.	*Anabolia laevis* Zett.	●		1,3	26	12
-	*Anabolia* sp.	●		0,46	9	17
14.	*Glyphotaelius pellucidulus* Retz.	●	●	0,20	4	4,19
15.	*Limnephilus auricula* Curt.	●		0,10	2	19
16.	*L. extricatus* McL.	●	●	2,0	40	1, 2,5,12,18
17.	*L. flavicornis* (Fabr.)	●		0,10	2	20,
18.	*L. fuscicornis* Ramb.		●	0,05	1	3
19.	*L. germanus* McL.	●		0,20	4	12
20.	*L. ignavus* McL.	●		0,05	1	12
21.	*L. lunatus* Curt.	●	●	11,9	230	1,2,5,7,9,11-15,17,
22.	*L. luridus* Curt.	●		0,10	2	12
23.	*L. nigriceps* (Zett.)	●		0,05	1	17
24.	*L. rhombicus* (L.)	●	●	0,36	7	1,3,5,12
25.	*L. sparsus* Curt.		●	0,05	1	4
26.	*L. stigma* Curt.	●		0,10	2	19
-	Limnephilidae non det.	●	●	3,1	61	2,5,8,10,11,14,15,17, 19,21
27.	*Chaetopteryx villosa* (Fabr.)	●	●	28,4	549	3,6-14,17,18,21
28.	*Micropterna sequax* McL.		●	0,10	2	9
29.	*Potamophylax latipennis* (Curt.)		●	0,10	2	21
30.	*P. nigricornis* (Pict.)	●	●	5,8	113	9-12,14,21
-	*Potamophylax* sp.		●	0,20	4	16,18
31.	*Allogamus auricollis* (Pict.)		●	2,6	52	11
32.	*Halesus digitatus* (Schr.)	●		0,10	2	5,
33.	*H. tesellatus* (Ramb.)		●	0,10	2	21
-	*Halesus* sp.		●	0,15	3	13,14
34.	*Sericostoma personatum* (Spence)	●	●	5,7	111	5,9,10,11,17,21
35.	*S. schneideri* Kol.		●	0,41	8	9,21
-	*Sericostoma* sp.		●	4,4	85	9,16,21
36.	*Beraea pullata* (Curt.)		●	0,36	7	9
37.	*Beraeodes minutus* (L.)		●	0,41	8	11
38.	*Ernodes articularis* (Pict.)		●	0,05	1	21
39.	*E. vicinus* (McL.)		●	0,15	3	11
		23 taxa 21 spec.	32 taxa 28 spec.	100%	1927	

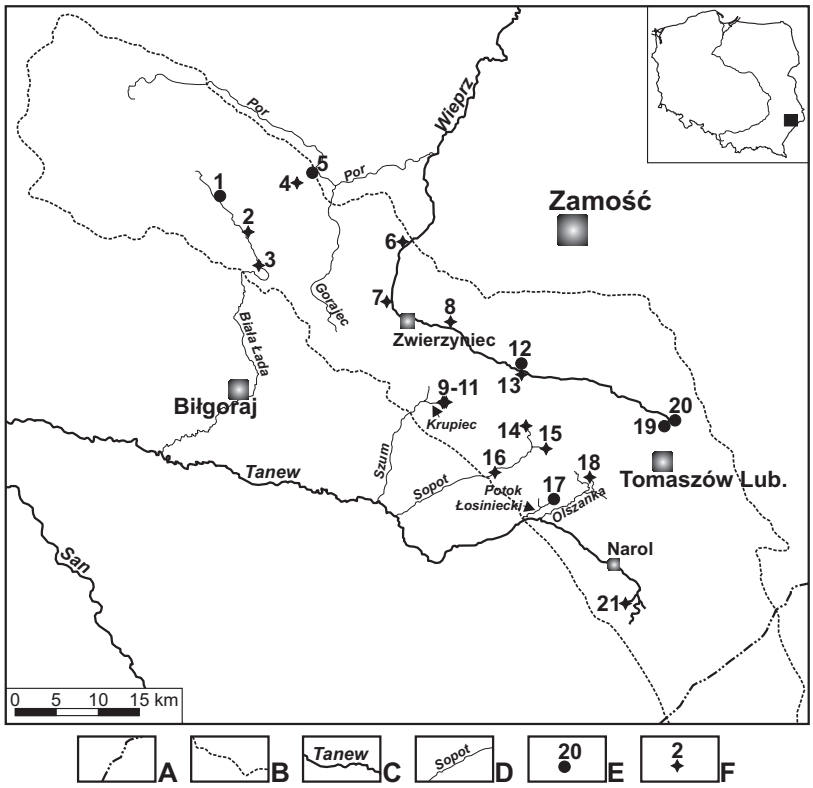

Fig. 1. Study area and investigated study sites. A – border of Poland, B – border of the Roztocze region (after Buraczyński), C – large rivers, D – medium and small rivers, E – a valley spring, F – a valley-side spring

class belonged *Chaetopteryx villosa* – the species occurring in streams, rivers and springs as well, and *Apatania muliebris* – a typical crenobiont species. In the class of dominants in the first spring type two species appeared: *Chaetopteryx villosa* and *Limnephilus extricatus* – similar to the first species in habitat preferences. In the second type of spring the dominants were crenophilous *Potamophylax nigricornis* and *Sericostoma personatum*. The classes of subdominants were also different – in valley springs it covered *Anabolia laevis* – eurytopic and crenoxene species occurring in water bodies and rivers as well, in valley-side springs – *Plectrocnemia conspersa* – crenophilous species, *Rhyacophila nubila*, *R. fasciata* – both typical rheophilous species, *Allogamus auricollis* – the species inhabiting streams and rivers and *Limnephilus lunatus*.

In the analysis of faunistic similarities (Fig. 2) the values of the index were rather low in general (many reached 0 and the averages were small) which indicated large individualism of the study sites. However, three blocks could be distinguished with quite high values over 10% and sometimes even 20%. Very

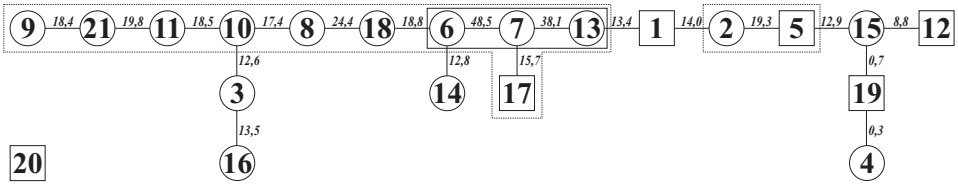

Fig. 2. Dendrite of faunistic similarities. Numbering of study sites like in the text – the numbers in the circle – valley springs, in the square – valley-side springs.

clear was the block encompassing study sites 6, 7, 13 – with the extreme values of index of ca. 40%. Those were valley-side springs of the river Wieprz with impoverished and/or degraded fauna consisting of not numerous and common species like *Limnephilus lunatus* and *Chetopteryx villosa*. The second and the largest block covering 10 study sites, except for no. 17, consisted of valley-side springs also – those were the springs of rivers smaller than Wieprz and in most cases isolated in forests or – in case of Wieprz – it was also the forest spring, situated in a nature reserve. Study sites 9, 21, 11, 10, 8 and 18 were characterized by medium and the highest species richness as well as the presence of numerous crenobiont and crenophilous species. The third visible block covered the springs of the river Biała Łada and Por which were anthropogenically changed in Roztocze. Their fauna had mixed character due to the presence of crenobionts and crenophilous species as well as common ones.

The values of naturality indexes for all study sites reached the values ranged from low to medium (Fig. 3). Qualitative naturality index (Wns) varied from 1 to 9.2, quantitative one (Wni) – from 1 to 10.4. The highest scores belonged to the spring of the river Sopot (14) and the spring of the river Krupiec (10) where only 5 species occurred at each site but all of them belonged to crenobionts or crenophiles with high ecologic significance index (like 8 or 16). Relatively high scores were also found at springs of the river: Niepryszka (site 9), Krupiec (the second spring – 11) and Tanew (21) – Wns from 6.8 to 7.7, Wsi – 41.9. The share of crenobionts and crenophiles was also high, however, the values were lowered by the presence of eurytopes and rheobionts.

In the examined area 5 species from the Polish Red list of Trichoptera (16) was found: *Apatania muliebris*, *Ernodes vicinus* (LC category), as well as *Beraea pullata*, *Beraeodes minutus* and *Limnephilus germanus* (DD category). First four species are typical of springs – *Apatania muliebris* occurred in 7 springs in the studied area and in most cases in large numbers, the next three were separately recorded in single springs and reached small specimen numbers. The most interesting in this group is *Limnephilus germanus* – a very rare species known from a few lakes in Poland (7). At three study sites from the springs of the river Krupiec and Tanew, the only one caddisfly species protected in Poland by law (15) – *Crunoecia irrorata* – was also found.

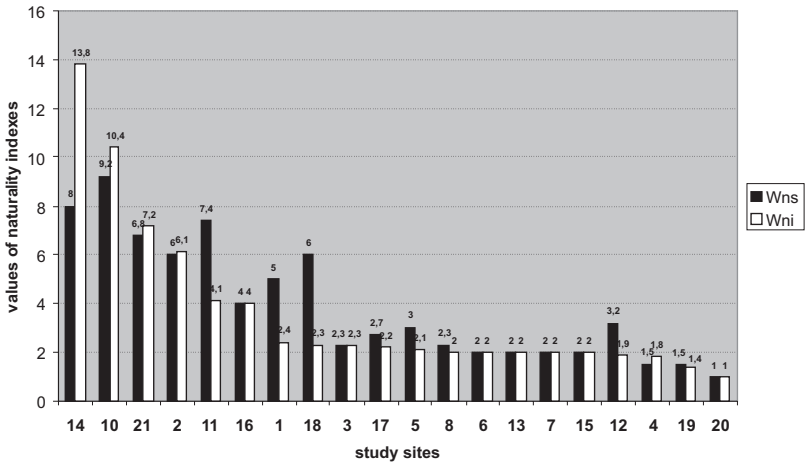

Fig. 3. The values of qualitative and quantitative naturality indexes (Wns, Wni) at particular study sites

DISCUSSION

In contrast with the mountain springs of Poland, data about caddisfly of spring in lowlands or uplands are still insufficient. The lack of basis on the original species composition of such habitats makes hard to conclude about the scale of changes in caddisfly species or assemblages in springs. So far, 78 caddisfly species have been known from lowland and upland springs (4, 6, 8, 9, 11, 14, 16). Together, with seven ones given in this paper, it makes 85 species in general. It is ca. 30% of the whole Polish trichopterofauna (Buczyńska unpubl. data).

First data on caddisflies of springs in Roztocze are very sparse: only seven species were found by Riedel and Majecki (14). Except for *Oligoplectrum maculatum* in the spring of the river Wieprz (in this paper study site 8), all of them have been also found during the studies presented by the author. With the species mentioned above, it has been 40 species known from the springs of Roztocze so far, which is 30% of the whole caddisfly fauna of the Lubelszczyzna region.

Comparing the spring fauna of Roztocze with other not numerous study results on caddisflies from upland or lowland springs it can be noticed that as for the species composition it is closely associated with: the springs of the vicinities of Olsztyn (15) – 19 common species, springs of the Kraków–Częstochowa and Miechów Uplands (6) –15 common species), and springs in the Kazimierski Landscape Park in the Lublin Upland (14) – 12 common species. Analyzing 19 common species from the vicinities of Olsztyn, two phenomena can be noticed: the presence of rare and interesting species typical of springs (e.g. from Beraeideae family), as well as a crucial share of crenoxenes – in the studied area they

were found mainly in a valley spring type. In turn, in springs of the Kraków–Częstochowa and Miechów Uplands the important share of the common species was that of rheophiles. As for the common species from the Lublin Upland – they showed the highly mixed character – from typical of springs ones, rheophiles, small water body species to those associated with astatic waters.

According to Czachorowski (8), the caddisfly faunas within Poland are very diversified – in lowland springs there are more species typical of standing waters, in upland ones – rheophiles. The fauna of springs in Roztocze seems to have a separate and, at the same time – complex character. There is a crucial share of crenophilous and crenobiontic species – some of them are common ones in the whole country (like *Plectrocnemia conspersa*, *Potamophylax nigricornis*, *Sericostoma personatum*), some are very vulnerable like these from the Red list or *Crunocecia irrorata* – protected by law. Rheobionts are also present (e.g. *Rhaycophila nubila*, *Hydropsyche instabilis*), however – in contrast with the statement of Czachorowski – the share of species preferring stagnant waters is very significant in Roztocze (e.g. some species from the genus *Limnephilus* and species inhabiting small pools within forests like *Glyphotaelius pellucidula* and *Trichostegia minor*). Very typical feature of springs in Roztocze is the complete lack of the family Goeridae whose representatives are very common in springs of Poland (8, 11, 12, 16). What is more important – they are present, sometimes in large numbers, in the rivers of the examined area (Buczyńska unpubl. data). They were also not found in the springs of the Lublin Upland (4). The second specific character of springs in Roztocze is the presence of *Limnephilus lunatus*. This species belongs to eudominants in general analysis and in valleys springs, as well as to subdominants in valley-side springs. It is known from permanent streams, rivers, ponds, lakes, canals and marshes (19) and – on the basis of this studies springs should be added. Due to climate and morphology, Roztocze is a very special region where many submontane or montane plant and animal species appear. In case of springs, only *Allogamus auricollis* found in the springs of the river Krupiec can be regarded as the representative of this element (18).

The differences of the faunas are even more visible while analyzing two types of springs in Roztocze. The species inhabiting valley springs are stagnophilous eurytopes mainly, with single crenobionts and crenophiles. In Roztocze, every water body, even of spring type, can be treated by caddisflies as a substitute for a lake or pond (3). Valley springs with the belt of sedges and grasses by the shore are suitable habitats for many Limnephilidae. Three valley springs (sites 2, 5, 6) are situated within forests and leaves are additional food base for some species. Valley-side springs have more typical fauna of this kind of habitat – its core is formed by crenophiles and crenobionts, rheophiles are also a big group, stagnant water species are accidental. Valley-side springs are the sites where the most valuable species occur exclusively (red-listed and protected ones).

The complex and mixed character of the fauna may result from the conditions of the examined study sites – some springs are isolated in forests and there is no harmful human impact on caddisflies (for example study sites 6, 11, 20), others are anthropogically changed by e.g. eutrophication and damming, which eliminate vulnerable stenotopic species (for example study sites 7–10). Perhaps this is the reason why there is so high similarity between faunas of Roztocze and the Kraków–Częstochowa and Miechów Uplands – this region is regarded by Czachorowski as degraded and with impoverished fauna (8). On the other side, the third most similar fauna was found in the Kazimierski Landscape Park with well preserved and undamaged springs. Also the values of naturality indexes prove that some springs of Roztocze are of great natural value. The spring of the river Sopot in Husiny (site 14) can be a model spring of the examined region with crenobionts and crenophiles only, the spring of the river Krupiec (study site 10) has very similar character, however – the spring of the river Tanew in Dębiny (site 21) is also rich in spring species but also maintains the highest number of species in general among all of the study sites. In case of springs, worth protecting can be the typical spring species composition, as well as high species richness with a significant share of rare, red-listed or protected ones. In the discussed springs 10 and 21 there is *Crunoecia irrorata* – the species which shows the tendency to become more rare and less abundant in Europe (10) and Poland as well. What is more interesting – the co-occurrence of this species with other red-listed ones in Finland was also found (10). Admittedly, Szczęsny (17) did not include this species into the Red List of Poland but it should be there. The relationship given by Ilmonen (10) in Finland confirms in Roztocze at the study site 11 totally – in this spring four species from the Red List are also present. In study site 21 this species co-occurs with red-listed *Apatania muliebris*.

It can be concluded that these three study sites are the most valuable springs in Roztocze and especially the spring of the river Krupiec should be treated with great respect and stay untransformed in any way. Without doubts, the most important for caddisflies are valley-side springs. However, study site 6 belonging to valley springs provides another red-listed caddisfly *Limnephilus germanus*, known from lakes only in Poland. The record given in the paper extends its known so far habitat preferences in the country.

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