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Helminths of *Talpa europaea* (Insectivora, Talpidae) in southwestern Europe

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Abstract

The helminth fauna of the European mole (*Talpa europaea* L., 1758) was studied on the basis of 269 host individuals from 39 localities in France and Spain. Twelve helminth species were recorded: two digeneans – *Ityogonimus lorum* (Dujardin, 1845) (Brachylaimidae) and *Nephrotrema truncatum* (Leuckart, 1842) (Troglotrematidae); one cestode – *Multitesticulata filamentosa* (Goeze, 1782) (Dilepididae); and 9 nematodes – *Capillaria talpae* (Siebold, 1850), *Eucoleus oesophagicola* Sołtys, 1952, *Liniscus incrassatus* (Diesing, 1851), *Trichuris feliui* Ribas et Casanova, 2004 (Trichuridae), *Parastrongyloides winchesi* Morgan, 1928 (Strongyloididae), *Porrocaecum* spp. larvae (Ascarididae), *Spirura talpae* (Gmelin, 1790) (Spiruridae), *Tricholinstowia linstowi* (Travassos, 1918) and *T. mornanti* Durette-Desset et Vaucher, 1974 (Heligmonellidae). In the general helminth fauna, *S. talpae* was found the most prevalent species (43.9%) and with the highest infection intensity. Prevalences of *I. lorum*, *L. incrassatus*, *Porrocaecum* spp. and *T. mornanti* ranged from 9.7 to 17.5% and mean intensities between 1.4 and 2.3. *L. capillaris*, *Porrocaecum* spp., *S. talpae* and *T. mornanti* are core species in the helminth community of *T. europaea*. The rest of species are considered satellite. All the species found in males are present in females except *E. oesophagicola*. No significant differences were found between males and females in quantitative parameters. Values of Lefkovitch's index indicate a negative binomial distribution for all species. Correlation between altitude of the biotopes and species richness was not significant. Qualitative and quantitative data were compared with other known helminthological studies of *Talpa* spp. in Europe.

Key words

Talpa europaea, southwestern Europe, helminths

Introduction

Two species of the genus *Talpa* L., 1758 (Insectivora, Talpidae) occur in the Iberian Peninsula, the Iberian mole *Talpa occidentalis* Cabrera, 1907 and the European mole *Talpa europaea* L., 1758. *T. occidentalis* is an Iberian endemic having a wide distribution on the peninsula (Filippucci *et al*. 1987), whereas the European mole is restricted to northeastern Spain and several Mediterranean areas (Palomo and Gisbert 2002). In Eurasia, *T. europaea* is distributed in a wide area extending from Great Britain to the rivers Ob and Irtysh in West Siberia (Mitchell-Jones 1999, Nowak 1999). The ethology of *Talpa* spp. as burrowing mammals determines their particular helminth faunas (Prokopič and Grulich 1976, Casanova *et al*. 1996, Milazzo *et al*. 2002). Helminth species from the European mole, Iberian mole and *Talpa* spp. in Spain were cited by Cordero del Campillo *et al*. (1994). In *T. europaea*, 5 species only were listed: *Capillaria* spp., *Moniliformis circumflexum* (Molin, 1858), *Parastrongyloides winchesi* Morgan, 1928, *Spirura talpae* (Gmelin, 1790) and *Tricholinstowia mornanti* Durette-Desset et Vaucher, 1974. In *Talpa* spp. (including Iberian and European moles) from different localities of the Iberian Peninsula, the latter authors cited: *Eucoleus oesophagicola* Sołtys, 1952, *Ityogonimus lorum* (Dujardin, 1845), *Liniscus incrassatus* (Diesing, 1851), *Multitesticulata filamentosa* (Goeze, 1782), *Nephrotrema truncatum* (Leuckart, 1842), *Omphalometra flexuosa* (Rudolphi, 1809), *Porrocaecum* spp., larvae, *P. winchesi*, *Soboliphyme* spp., *S. talpae* and *T. mornanti*. In the Iberian mole (*T. occidentalis*), the list of species given by Cordero del Campillo *et al*. (1994), under the name of *T. caeca* Savi, 1822, includes: *I. lorum*; *Ityogonimus ocreatus* (Goeze, 1782), *M. filamentosa*, *P. winchesi* and *Porrocaecum* spp. All helminth species, cited in *T. occidentalis* by Alvarez Mascato *et al*. (1994) and Casanova *et al*. (1996), were mentioned by Cordero del Campillo *et al*. (1994).

In this article, we report the helminth parasites of *T. europaea* from northeastern Spain and the French Pyrenean Mountains and compare our results with previous faunistical and ecological data on helminth faunas of different species of Eurasian moles.

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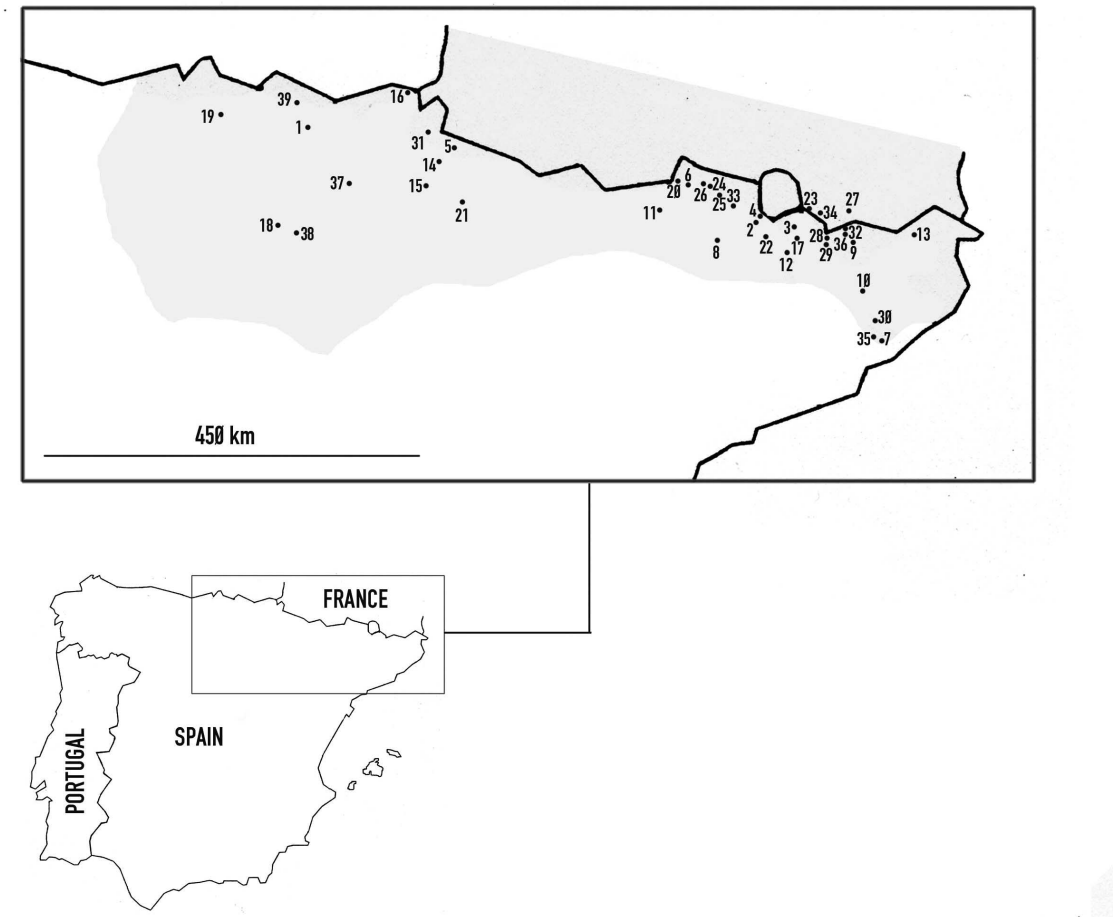

Fig. 1. Map of the Iberian Peninsula showing capture localities of *Talpa europaea*. The distribution of *T. europaea* (modified from Palomo and Gisbert 2002) is represented as a shaded area

Materials and methods

A total of 269 European moles were surveyed for helminths (92 males, 103 females and 74 individuals with undetermined sex). Hosts were obtained either by the assistance of official institutions (museums and natural park offices) or captured by the authors. Specimens were captured using special traps for hypogean small mammals. Individuals were dissected after capture. Several hosts were frozen or fixed, in 70% ethanol or formaline and necropsied later. The hosts came from 39 localities in France or Spain (Fig. 1, Table I). The studied ecosystems included a wide variety of habitats used by *T. europaea*, i.e. agricultural lands, pastures, meadows, edges of spruce forest and forest. The altitude of each site was identified according to Servicio Geográfico del Ejército (1985).

Helminths recovered were isolated and stored in 70% ethanol. For microscopic study, platyhelminths were stained in Semichon acetocarmine and mounted in Canada balsam. Nematodes were cleared in Amann lactophenol. The ecological terminology and quantitative parameters were according to Bush *et al*. (1997).

The Kolmogorov-Smirnov test was performed to determine the distribution of the parasites in the host. Statistical analysis compared the prevalences (χ^2 test) and mean intensities of infection (ANOVA test). Spearman's test was used to determine the correlation between altitude of the sampled points and helminth richness. Lefkovitch's index (Lefkovitch 1966) was performed to check if a negative binomial distribution was observed (L>0).

Results

A total of 12 species were recorded (Table II). The general prevalence of all species was 74%. The quantitative data related to the sex of the host (11 species in males, 10 species in females) had no significant differences between males and females in species richness. *Trichuris feliui* was found in an unsexed host specimen only.

The helminth infracommunities showed a clear tendency towards low number of species. Infracommunities of one (45.5%) or two (21.6%) species prevailed; only 6.3% and

Table I. Localities of capture of *Talpa europaea* in the present study. Locality code (in Fig. 1)

Locality code	Locality	Province	Altitude (m a.s.l.)	N
1	Abadiano	Vizcaya	126	3
2	Ainet de Besan	Lleida	1275	1
3	Alp	Girona	1159	10
4	Areu	Lleida	1275	3
5	Arrayoz	Navarra	270	2
6	Arròs	Lleida	1000	69
7	Breda	Girona	164	33
8	Cabdella	Lleida	1086	22
9	Camprodon	Girona	950	4
10	Cantonigrós	Barcelona	220	1
11	Cerler	Huesca	1550	3
12	Coll de Pal	Barcelona	2080	1
13	Darnius	Girona	194	1
14	Elizondo	Navarra	202	25
15	Eugui	Navarra	500	1
16	Fuenterrabia	Guipuzcoa	24	16
17	La Molina	Girona	1500	4
18	Labastida	Álava	562	1
19	Lanestosa	Vizcaya	289	14
20	L'Artiga de Varradós	Lleida	1500	3
21	Lizarraga	Navarra	625	4
22	Martinet	Lleida	1000	1
23	Odeillo (Col de la Perche)	France	1600	6
24	Pla de Beret	Lleida	1840	6
25	Port de la Bonaigua	Lleida	2060	2
26	Presa Aiguamotx	Lleida	1400	1
27	Pi de Conflent	France	1000	1
28	Queralbs	Girona	1220	2
29	Ribes de Freser	Girona	908	4
30	Sant Hilari de Sacalm	Girona	805	1
31	Santesteban	Navarra	144	1
32	Setcases	Girona	1265	4
33	Son de Pi	Lleida	1393	4
34	Sant Pere dels Forcats	France	1580	4
35	Santa Fe del Montseny	Barcelona	650	2
36	Tregurà de Dalt	Girona	1050	1
37	Urbasa	Navarra	600	1
38	Villabuena de Álava	Álava	486	10
39	Zaldivar	Vizcaya	60	13

N – number of hosts; m a.s.l. – meters above sea level.

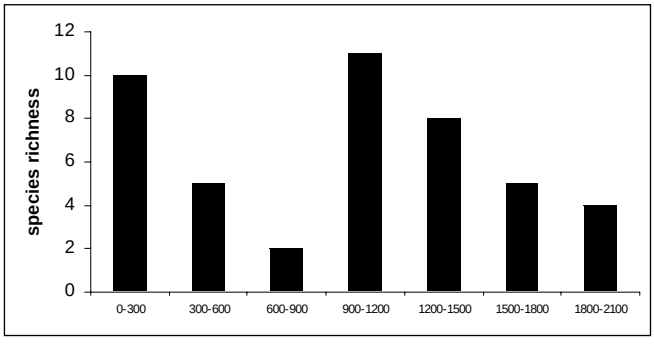

Fig. 2. Helminth species richness in *Talpa europaea* according to the altitude

0.4% of the hosts were infected by three or four species, respectively.

All species showed a not normal distribution (Kolmogorov-Smirnov test) (Table I). *T. feliui* was not considered because it was recovered in a single individual only. *S. talpae* was the species with higher value in Lefkovitch's index (Table II). No significant correlation between the altitude and the species richness was found (Spearman's test: –0.103, $p<0.549$) (Fig. 2).

Discussion

Of the 12 species reported in the studied populations of the European mole, five are characterised by a low host specificity. In the Iberian Peninsula, they are also known from other Soricomorpha (Soricidae and Talpidae): *E. oesophagicola* from *Neomys fodiens* (Pennant, 1771), *Sorex araneus* (L., 1758) and *Talpa* spp.; *L. incrassatus* from *Crocidura russula* (Hermann, 1780), *N. fodiens* and *S. araneus*; *N. truncatum* from *N. fodiens*, *Sorex minutus* (L., 1766), *C. russula*, *S. araneus* and *Talpa* spp.; *Porrocaecum* spp. from *C. russula*, *S. araneus* and *Talpa* spp.; *P. winchesi* from *C. russula*, *Crocidura suaveolens* (Pallas, 1811), *S. araneus*, *S. minutus* and *T. occidentalis* (Alvarez Mascato *et al*. 1994, Cordero del Campillo *et al*. 1994, Casanova *et al*. 1996). *N. truncatum* is also recorded from *Eliomys quercinus* L., 1766 (Rodentia, Gliridae) (Cordero del Campillo *et al*. 1994). Other 7 detected species are strictly specific to *Talpa* spp.

Comparing our qualitative results with others about the same host species, we found a great similarity with the species lists reported by Vasilev (1949) in the surroundings of Leningrad (now St. Petersburg), Petrov and Savinov (1959) and Savinov (1960) in the Kalinin (now Tver) District in Russia; Sołtys (1954) and Furmaga (1959) in Poland; Stammer (1955) in Germany; Morozov (1957), Grigorev (1963) and Merkusheva (1969) in Belarus; Prokopič (1959) and Prokopič and Genov (1974) in former Czechoslovakia and Bulgaria; Chiriac and Hamar (1966) in Romania; Genov and Dimitrova (1966), Prokopič and Genov (1974) and Genov (1984) in Bulgaria; Andreyko (1969) in Moldova and Prokopič and Grulich (1976) in Austrian Alps. All these studies have been carried out in Central and East Europe where *T. europaea* lives in habitats similar to those in north Spain; it also has a similar diet to that of other *Talpa* spp. in Europe (Beolchini and Loy 2004).

The most interesting data to compare our results were those reported by Shimalov and Shimalov (2001) in Belorussian Polesie. These authors examined 93 common moles caught between 1981 and 2000. They reported 21 species (four digeneans, seven cestodes and ten nematodes). This number of species was higher than those reported for Western Europe. Ten of these species were cestodes, nematodes, and trematodes with prevalences lower than 10% except in the case of *Alaria alata* (Goeze, 1782) (11.7%) and *Porrocaecum* spp. (14.1%). Only six species found in this study are

Table II. Helminth parasites recorded in *Talpa europaea* in the course of the present study

Helminth species	Site	Total						Male hosts				Female hosts			
		P%	RI	MI	MA	KS*	L	P%	RI	MI	MA	P%	RI	MI	MA
Brachylaimidae															
Ityogonimus lorum	intestine	9.7	1–6	2.30	0.22	8.430	0.61	8.7	1–5	2.37	0.21	6.8	1–4	2.58	0.17
Troglotrematidae															
Nephrotrema truncatum	kidneys	2.2	1–4	2.0	0.04	8.680	0.40	12	1–4	2.25	0.27	1.9	1–2	1.5	0.03
Dilepididae															
Multitesticulata filamentosa	intestine	4.1	1–3	1.45	0.06	8.748	0.32	4.34	1–3	1.75	0.07	3.88	1–2	1.25	0.05
Trichuridae															
Capillaria talpae	stomach	2.6	1–2	1.28	0.03	8.776	0.22	2.2	1–2	1.5	0.03	3.9	1–2	1.25	0.05
Eucoleus oesophagicola	oesophagus	0.4	2–2	1	4×10^{-3}	8.538	0.41	1.1	2–2	0.5	5.5×10^{-3}	–	–	–	–
Liniscus incrassatus	urinary bladder	17.5	1–8	1.87	0.33	7.480	0.58	27.2	1–8	2.12	0.58	17.5	1–6	1.55	0.27
Trichuris feliui	intestine	0.4	10–10	10	0.04	–	–	–	–	–	–	–	–	–	–
Ascarididae															
Parastrongyloides winchesi	intestine	5.2	1–7	2.43	0.13	8.676	0.65	15	1–7	1.33	0.20	5.8	2–4	6.33	0.37
Porrocaecum sp. larvae	intestine	11.5	1–6	1.97	0.23	8.220	0.53	3	1–3	2	0.06	16.5	1–6	2.23	0.37
Heligmonellidae															
Spirura talpae	stomach	43.9	1–132	11.55	5.07	6.007	0.97	38	1–132	14.34	5.45	43.7	1–100	9.2	4.02
Tricholinstowia linstowi	intestine	1.1	1–10	1.09	0.01	8.492	0.85	1.1	1–1	1	0.01	1.9	1–10	5.5	0.10
Tricholinstowia mornanti	intestine	12.3	1–40	1.40	0.17	7.390	0.93	20.7	1–30	4.58	0.95	11.7	1–40	7.78	0.91

P% – prevalence, RI – range of the intensity, MI – mean intensity, MA – mean abundance, KS – Kolmogorov-Smirnov test (Z value), L – Lefkovitch index, $^{*}p<0.001$ for all the species.

stenoxenous of *Talpa* hosts (*I. ocreatus*, *Staphylocystis bacillaris* (Goeze, 1782), *C. talpae*, *Longistriata vigisi* Petrov et Savinov, 1959, *S. talpae*, *T. talpae* and *T. talpae* was the species most prevalent (16.5%). The generalist species are larvae or adults of species characteristic for other hosts such as *Isthmiophora melis* (Schrank, 1788) (Echinostomatidae), a typical parasite of mustelids that in Belarus are the dominant species in the helminth community of *Lutra lutra* L., 1758 and also found in *Mustela lutreola* L., 1761 and *Mustela vison* Schreber, 1777 (Shimalov *et al*. 2000). In our study, of the 12 species found, seven are stenoxenous of *Talpa* hosts, but different from the species cited by Shimalov and Shimalov (2001) except *C. talpae* and *S. talpae*.

The most important studies on the quantitative structure of the helminth fauna of *T. europaea* were carried by Petrov and Savinov (1959), Prokopič and Genov (1974), Prokopič and Grulich (1976), Genov (1984), Shimalov and Shimalov (2001) and Žasitytė and Grikienienė (2001). The species richness found in these studies (9–12) was similar to our data except for the above-mentioned studies in Belarus (Shimalov and Shimalov 2001). Table III shows the prevalence of the species found in our study and in the above-mentioned works. The remaining species found by those authors are, in the great part, influenced by the biogeographical distribution of the studied populations and sharing a number of helminth species with other hosts in the same habitats. The cited helminthological studies on *T. europaea* show that nematodes are the most prevalent species in the helminth fauna of this host. Only *Porrocaecum* spp. was recorded in all the helminthological surveys and *S. talpae* seems to be the most frequent (Table III).

Our study confirms the low infection rates of trematodes and cestodes recorded in the course of the previous helminthological surveys of these hosts.

The comparative study of the populations of the endemic Iberian mole and those of the European mole in Iberian Peninsula showed some faunistic and ecological differences (Casanova *et al*. 1996; Ribas and Casanova 2004a, b). Eight of the 14 species recorded in the Iberian moles are also present in *T. europaea*, according to our results. Qualitatively, species found in *T. occidentalis* and absent in *T. europaea* are: *I. ocreatus*, *O. flexuosa*, *Moniliformis* spp. (Casanova *et al*. 1996), and *Soboliphyme occidentalis* Ribas et Casanova, 2004. The presence of the one species of the genus *Trichuris* Roeder, 1764 in *T. europaea* is unusual. The only other species of this genus is *Trichuris* spp., parasite of *Mogera* spp. (Talpidae) in Japan (Yokohata *et al*. 1989).

Quantitative helminthological results in Iberian populations of *T. europaea* and *T. occidentalis* are similar except for *S. talpae* having prevalence four times lower in *T. occidentalis* (11.5%) (Casanova *et al*. 1996). In Iberian moles, the most prevalent species was *Liniscus capillaris* (Linstow, 1882) (Trichuridae) and the remaining species showed similar prevalences as these in *T. europaea* (Casanova *et al*. 1996).

Considerable differences were found between the Iberian *T. europaea* and the endemic Italian species *T. romana* Thomas, 1902 (Milazzo *et al*. 2002). Italian moles are characterised by low helminth species richness, harbouring one trematode, one cestode and four nematode species only. Prevalences also were different in the two populations, with higher values in *T. romana* except for *S. talpae* (18.4%) (Milazzo *et al*. 2002).

In our study, no significant differences were found between male and female helminth faunas as in the case of *T. romana* (Milazzo *et al*. 2002). Differences between sexes were found by Prokopič and Grulich (1976) in *T. europaea* and Casanova *et al*. (1996) in *T. occidentalis*. In both cases these were attributed to the sexual dimorphism and high male vagility. No data are available in our study on the host age and this made difficult to explain the absence of differences in the parasitation between sexes.

In this study, we have surveyed helminths from 39 different localities between 24 and 2080 m above sea level. Most of the helminth species are found up to 1500 m (Fig. 2) (*I. lo-*

Table III. Prevalence (in %) of the helminth species found in *Talpa europaea* in our study and in different helminthological studies of this host

Helminth species	Petrov and Savinov 1959	Genov 1984	Prokopič and Genov 1974	Prokopič and Grulich 1976	Shimalov and Shimalov 2001	Žasitytė and Grikienienė 2001	Our study
I. lorum	–	–	–	–	–	–	9.7
N. truncatum	–	–	–	–	–	–	2.2
M. filamentosa	–	6.31	1.8	3.54	–	–	4.1
C. talpae	–	–	0.9	7.8	5.3	–	2.1
E. oesophagicola	–	–	–	–	–	–	0.4
L. incrassatus	–	19.82	–	–	11.7	32.2	17.5
T. feliui	–	–	–	–	–	–	0.4
P. winchesi	–	9.4	0.9	3.54	6.8	23.7	5.2
Porrocaecum spp.	36.5	2.7	12.6	27.65	14.1	54.2	11.5
S. talpae	–	6.31	2.3	38.29	5.3	–	43.9
T. linstowi	–	–	–	2.12	–	18.6	1.1
T. mornanti	–	–	–	–	–	–	12.3

rum, *M. filamentosa*, *C. talpae*, *L. incrassatus*, *T. feliui*, *P. winchesi*, *Porrocaecum* spp., *S. talpae*, *T. linstowi* and *T. mornanti*). Only several species (*L. incrassatus*, *N. truncatum*, *Porrocaecum* spp. and *T. mornanti*) reached higher zones. These zones are inhabited by various species of Soricidae which could share some helminth species with them. *T. mornanti* is a specialist species of *Talpa* spp. with presumably direct life cycle. For this species and its congener *T. linstowi*, the constant conditions of the subterraneous habitats could facilitate their life cycle, which may explain their wider distribution. Prokopič and Grulich (1976) found a similar distribution of *Tricholinstowia talpae* (Morgan, 1928) in the Austrian Alps (between 480 and 2100 m above sea level). In general, the helminth distribution in *T. europaea* described by Prokopič and Grulich (1976) is corresponding to our results.

Scarce data are available on the helminth infracommunities of *Talpa* spp. Shimalov and Shimalov (2001) have found a general prevalence (69.4%), which is similar to our results. They found multiple infections by 2–6 species in the 34% of the examined hosts; while in our study, multiple infections by 2–4 species show a similar prevalence (28.3%). In *T. romana*, Milazzo *et al*. (2002) revealed that the frequency of infracommunities with a single species is significantly higher than those containing more than one helminth species or unparasitised hosts. In general, our results and those found by different authors indicated that the helminth communities of *Talpa* spp. are isolationist (Pence 1990).

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