

MORPHOLOGY OF JUVENILE INSTARS OF *BANKSINOMA LANCEOLATA* (ACARI, ORIBATIDA, THYRISOMIDAE)

S. G. Ermilov

Center of Independent Examinations-NN, Nizhniy Novgorod 603107, Russia;
e-mail: ErmilovAcari@yandex.ru

ABSTRACT: The morphology of juvenile instars of the oribatid mite *Banksinoma lanceolata* is described and illustrated. In most aspects all juvenile instars are similar. Body with microgranular cerotegument. Gastronotic cuticle smooth, without sclerites. Sensilli elongate, spindle-shaped. Nymphs characterized by having small, spiniform interlamellar setae. Setal formulas of body (larva to tritonymph): genital (0–1–3–5), aggenital (0–0–1–1), anal (0–0–0–2), adanal (0–0–3–3), gastronotic (12–15–15–15) and epimeral (3–1–2, 3–1–2–1, 3–1–3–2, 3–1–3–3). Palpal setation similar for all juvenile instars: 0–2–1–3–9(+1 ω). Solenidia of leg tibia and genua not coupled (setae d absent). Tarsi II with one solenidion. The juveniles of *Banksinoma lanceolata* differ from juveniles of *Pantelozetes alpestris* by the morphology and colour of body cuticle; morphology of sensilli; length of some gastronotic setae; deutonymphal epimeral formula.

KEY WORDS: *Banksinoma lanceolata* (Michael, 1885), Thyrisomidae, morphology, juvenile instars, ontogeny, development, oribatid mite.

INTRODUCTION

The oribatid mite genus *Banksinoma* Oudemans, 1930 (Acari, Oribatida, Thyrisomidae) currently includes 19 named species. Collectively, the genus is cosmopolitan, except for the Antarctic and Ethiopian regions (Subías 2004; online version 2010). The morphology of juvenile instars in this genus has not yet been described in detail, although Grandjean (1953a) listed several characters of juveniles of an unidentified species (under the synonym *Thyrisoma*) as representing the family Thyrisomidae. Of other genera in the family there is little published information and it relates only to *Pantelozetes* Grandjean, 1953 — Tuxen (1943) briefly presented figures of a larva and nymph of *P. paolii* (Oudemans, 1913) and Shaldybina (1969, 1971) described all juveniles of *P. alpestris* (Willmann, 1929).

The purpose of the present work is to describe and illustrate the morphology of juvenile instars of *Banksinoma lanceolata* (Michael, 1885), specifically the nominate subspecies *B. lanceolata lanceolata* (Michael, 1885). It is the first such complete treatment for any member of *Banksinoma*. Adults of this species were redescribed and illustrated by several authors, including Willmann (1931), Bulanova-Zachvatkina (1975) and Weigmann (2006). *Banksinoma lanceolata* is distributed in the Holarctic region and Hawaii, and is the unique representative of *Banksinoma* known in the Central European part of Russia, from where the studied material was collected.

MATERIALS AND METHODS

Most of the studied mites of *Banksinoma lanceolata* were collected by myself in the European part of Russia (Nizhniy Novgorod region, Volo-

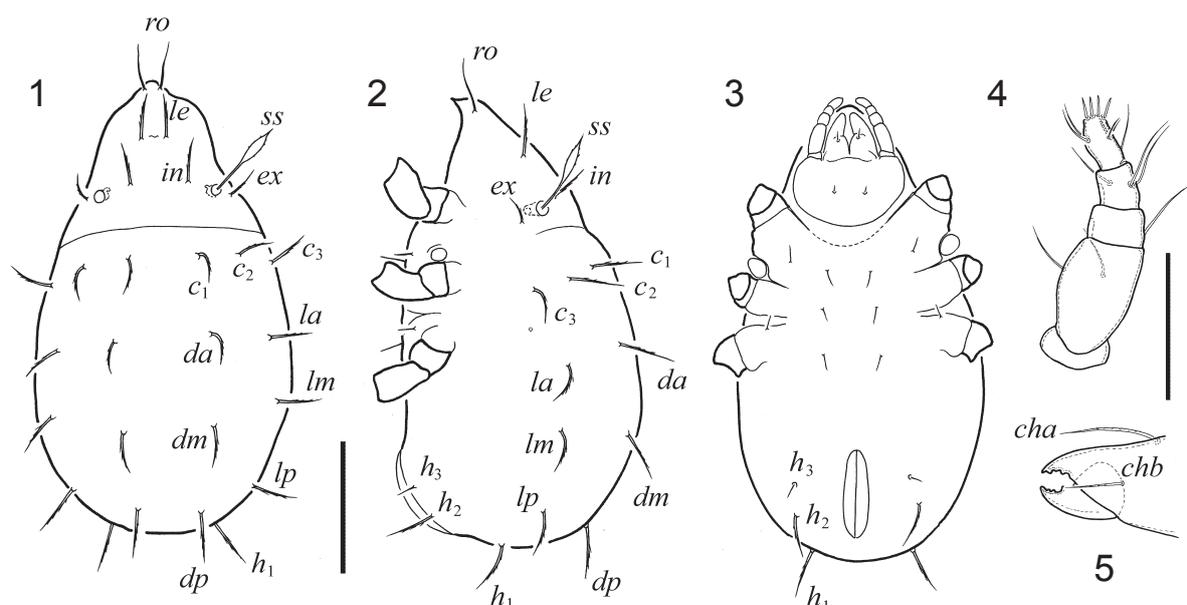
darskiy district) during the spring, summer and autumn of 2006–2009. Adults and juvenile instars were found in soil and moss near a marsh (56°12', 43°21'). The field-collected material included: 27 adults, 3 larvae, 4 protonymphs, 5 deutonymphs, 3 tritonymphs. Additional specimens of juvenile instars were obtained by myself from laboratory cultures (2 larvae, 1 protonymph, 10 deutonymphs, 6 tritonymphs). Methods of cultivation were presented earlier (Ermilov 2008). In the cultures all adult specimens and juvenile instars ate algae (*Pleurococcus* sp.).

The illustrated specimens were permanently mounted and studied on flat microscope slides. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the gastronotic region. Body width refers to the maximum width of gastronotic region in dorsal aspect. Length of body setae was measured in lateral aspect. All body measurements are presented in micrometers.

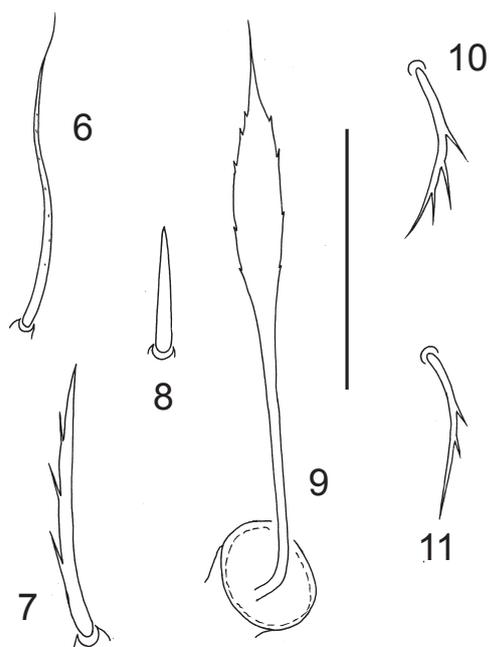
Terminology used in this paper follows that of F. Grandjean (see Travé and Vachon 1975 for many references). Formulae of leg setation are given according to the sequence trochanter-femur-genu-tibia-tarsus (famulus included). Formulae of leg solenidia are given according to the sequence genu-tibia-tarsus.

RESULTS

Dimensions. Total length of: larva 169 (168–172, n=3), protonymph 186 (180–192, n=4), deutonymph 246 (237–254, n=12), tritonymph 287 (282–299, n=4), adult 338 (328–344, n=15). Total width of: larva 94 (90–98, n=3), protonymph 107 (106–110, n=4), deutonymph 134 (131–139,



Figs 1–5. *Banksinoma lanceolata*, larva: 1 — dorsal view, legs removed; 2 — lateral view, legs partly removed, gnathosoma removed; 3 — ventral view, legs partly removed; 4 — palp; 5 — anterior part of chelicera. Scale bar 50 μm (1–3); 20 μm (4, 5).



Figs. 6–11. *Banksinoma lanceolata*, setae of juveniles: 6 — seta *ro* in larva; 7 — seta *in* in larva; 8 — seta *in* in protonymph; 9 — sensillus in larva; 10 — tarsal seta *a'* of leg I in larva; 11 — tarsal seta *pv''* of leg I in larva. Scale bar 20 μm .

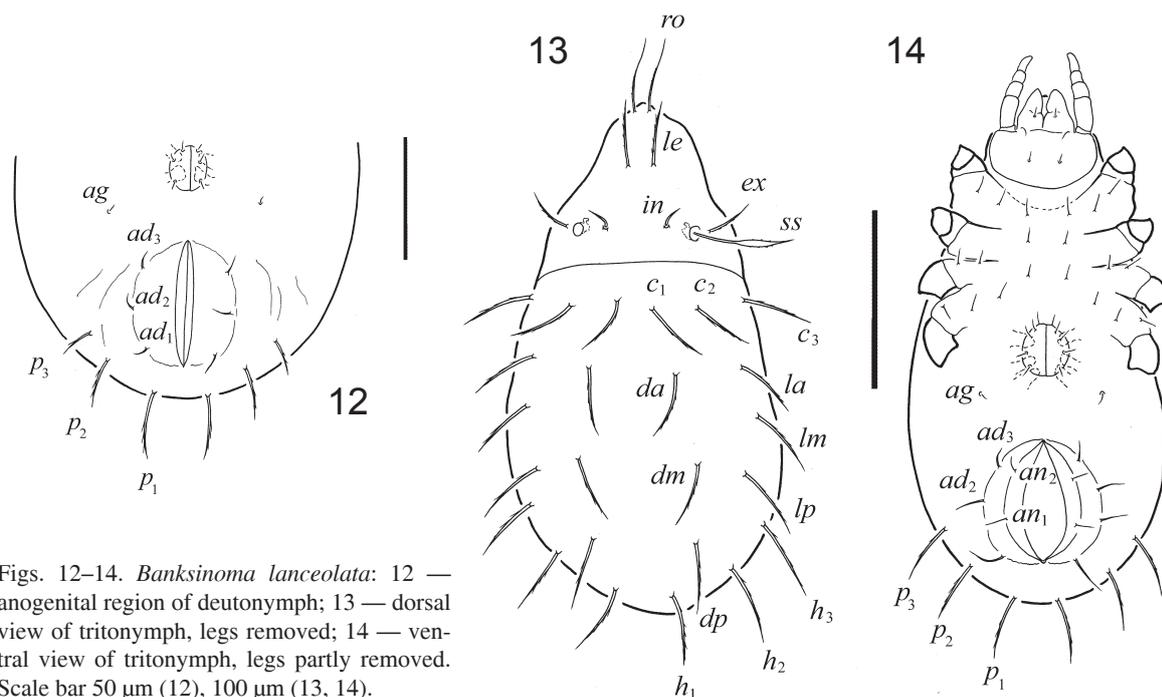
$n=4$), tritonymph 150 (143–155, $n=3$), adult 185 (184–188, $n=15$). Body of juveniles longer than wide, approximately by 1.8–1.9.

Integument. General body cuticle weakly sclerotized, colourless. Cuticle of gastronomic region smooth, without sclerites. Microgranular cerotegument covers body in all juvenile instars. Granules very small (diameter less 1); dorsally granules spherical, laterally granules conical, with

blunt-ended tips. Body setae without cerotegument.

Prodorsum (Figs. 1, 2, 13). Triangular, relatively short, about half-length of gastronomic region in lateral view. Rostrum conical, rounded in dorsal view. Setae *ro*, *le*, *ex* and *in* (in larva) well developed, straight or weakly curved, set on small tubercles (Figs. 6, 7). Setae with several barbs; those of *ro* minute, those of other setae with rather long barbs. Setae *ro* and *le* located dorsally; *ro* thinner than *le*, with thin tips. Nymphal setae *in* very short, thickened, spiniform (Fig. 8). Sensilli (*ss*) longest setae of prodorsum, elongate spindle-form, with well developed swelling and small flagellate tip, slightly barbed (Fig. 9). Bothridia funnel-shaped, with rather small opening. Length of prodorsal setae in larva: $ss > ro > in \approx le > ex$; in nymphs: $ss > ro > le > ex > in$. Comparison of prodorsal setae measurements of juvenile instars given in Table 1.

Gastronomic region (Figs. 1–3, 12–14). Broadly oval, rounded posteriorly. Larva with 12 pairs of gastronomic setae; nymphs with 15 pairs of gastronomic setae. Setae approximately identical length (20–24 in larva and protonymph, 24–28 in deutonymph, 36–41 in tritonymph), except h_3 shorter in larva and p_2 , p_3 shorter in proto-, deutonymph; all setae straight or weakly curved, with several long barbs, set on small tubercles. Cupules *ia*, *im* and *ip* developed, but often difficult or impossible to discern, according to individual specimen.



Figs. 12–14. *Banksinoma lanceolata*: 12 — anogenital region of deutonymph; 13 — dorsal view of tritonymph, legs removed; 14 — ventral view of tritonymph, legs partly removed. Scale bar 50 μ m (12), 100 μ m (13, 14).

Table 1.
Comparison of prodorsal setae measurements* of *Banksinoma lanceolata* during ontogeny

Character	Larva	Protonymph	Deutonymph	Tritonymph
	n=3	n=3	n=3	n=3
Length of rostral setae	24 (24)	28 (28)	32 (30–34)	43 (41–45)
Length of lamellar setae	20 (20)	24 (24)	29 (28–30)	38 (36–41)
Length of interlamellar setae	20 (20)	8 (8)	15 (14–16)	16 (16)
Length of sensilli	46 (45–49)	46 (45–49)	48 (45–49)	52 (49–53)
Length of exobothridial setae	13 (12–14)	16 (16)	20 (20)	27 (24–28)

*Given as mean (range)

Anogenital region (Figs. 3, 12, 14). Ontogenetic genital, aggenital, adanal, anal formulas (larva to tritonymph) 0–1–3–5, 0–0–1–1, 0–0–3–3, 0–0–0–2 respectively. All setae rather short, setiform, smooth. Cupules *ih*, *ips*, *iad*, and small opisthonotal gland opening (*gla*) developed, but often slightly visible or not visible absolutely, appearing in normal ontogenetic pattern.

Epimeral region (Figs. 3, 14). Setal formulas for epimeres: larva 3–1–2 (third setae of the first epimere (1*c*) forms protective scale over Claparède's organ); protonymph 3–1–2–1; deutonymph 3–1–3–2, tritonymph 3–1–3–3. Epimeral setae rather short, straight, thin, smooth, set on small apophyses.

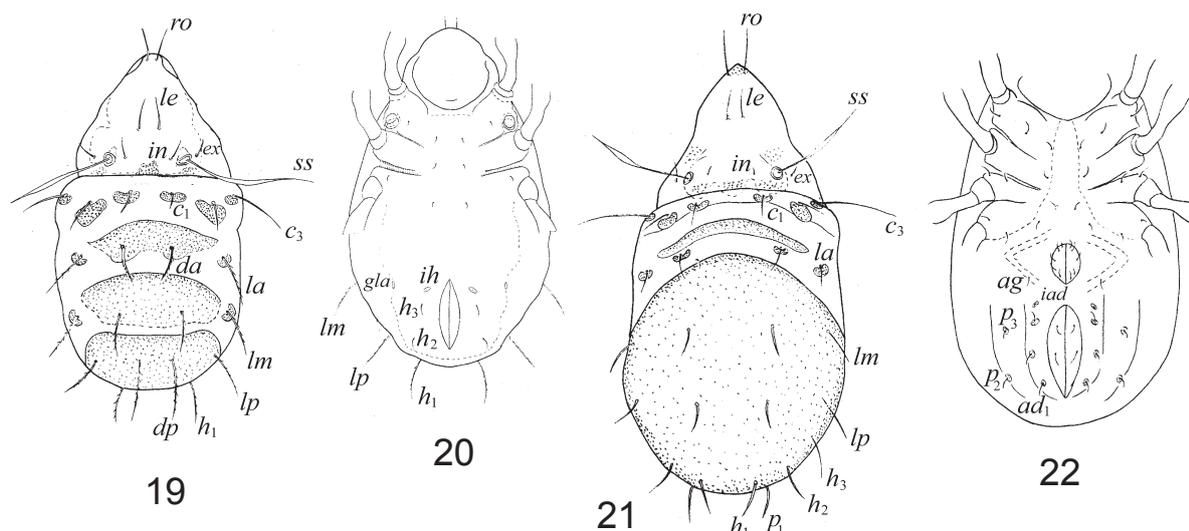
Gnathosoma. Subcapitular mentum wider than long. Hypostomal setae *a*, *m*, *h* of similar length, setiform, smooth. Palpal setation similar for all juvenile instars: 0–2–1–3–9(+1 ω). Palpal solenidion ω and eupathidium *acm* separate, not combined as “double horn” (Fig. 4). Chelicerae

with few blunt teeth on fixed and movable digits. Cheliceral setae long, setiform, barbed; *cha* considerably longer than *chb* (Fig. 5).

Legs (Figs. 15–18). Most setae long, barbed. Setae often with 2–4 long barbs in median-distal part (Figs. 10, 11). Tarsi II each with one solenidion in all instars. Tibia I–IV and genua I–III without setae *d*; solenidia isolated, set on small apophyses. Ontogeny of leg setae and solenidia given in Tables 2 and 3.

DISCUSSION

Except for the degree of gastronomic sclerotization in nymphs, juvenile instars of *Banksinoma lanceolata* are similar in structure to those of *Pantelozetes alpestris*, the previously best-known member of Thyrisomidae (Shaldybina 1969, 1971; Figs. 19–22). For example, they have identical gastronomic, genital, aggenital, adanal and anal setal formulas and have bodies and palps of similar form and structure. The main distinctive differ-



Figs 19–22. *Pantelozetes alpestris*, juveniles: 19 — larva, dorsal view, legs removed; 20 — larva, ventral view, legs partly removed, gnathosoma removed; 21 — tritonymph, dorsal view, legs removed; 22 — tritonymph, ventral view, legs partly removed, gnathosoma removed. From Shaldybina (1969).

Table 2.
Setal and solenidial counts* on legs of *Banksinoma lanceolata* during ontogeny

	Formula of setae	Formula of solenidia
Leg I		
Larva	0-2-2-3-16	1-1-1
Protonymph	0-2-2-3-16	1-1-2
Deutonymph	1-4-2-4-16	1-2-2
Tritonymph	1-4-2-4-18	1-2-2
Adult	1-5-2-4-18	1-2-2
Leg II		
Larva	0-2-2-2-13	1-1-1
Protonymph	0-2-2-2-13	1-1-1
Deutonymph	1-4-2-3-13	1-1-1
Tritonymph	1-4-2-4-15	1-1-1
Adult	1-5-2-4-15	1-1-1
Leg III		
Larva	0-2-1-1-13	1-1-0
Protonymph	1-2-1-1-13	1-1-0
Deutonymph	2-3-1-2-13	1-1-0
Tritonymph	2-3-1-3-15	1-1-0
Adult	2-3-1-3-15	1-1-0
Leg IV		
Protonymph	0-0-0-0-7	0-0-0
Deutonymph	0-2-2-1-12	0-1-0
Tritonymph	1-2-2-3-12	0-1-0
Adult	1-2-2-3-12	0-1-0

*Number of setae on trochanter-femur-genu-tibia-tarsus (including famulus); number of solenidia on genua-tibia-tarsus.

Grandjean (1953a, 1964) listed several characters of juveniles as representative of Thyrisomi-

dae and its then single genus, *Banksinoma* (given as the junior synonym *Thyrisoma*). These included: nymphs with 15 pairs of gastronotic setae, paraproctal atrichosy present; genital formula of nymphs 1-3-5; nymphal tibia and genua of legs without coupled setae *d* and solenidion; protonymphal formula of leg IV 0-0-0-0-7; leg tarsi II with one solenidion in all instars; palpal eupathidium *acm* and solenidion not joined as double horn; femur of palp with 2 setae in all juveniles. The juvenile instars of *Banksinoma lanceolata* are consistent in all these characters. In fact, the unnamed species studied by Grandjean was probably *B. lanceolata*, since it was the species he later mentioned in his study of solenidiotaxy (as *Thyrisoma lanceolata*).

ACKNOWLEDGEMENTS

The author cordially thanks Prof. Dr. Roy A. Norton (State University of New York, College of Environmental Science and Forestry, USA) for his consultations and help with collecting literature.

REFERENCES

- Bulanova-Zachvatkina, E.M. 1975. [The family Thyrisomidae]. In: M.S. Ghilyarov (ed.). *Opredelitel' obitayushikh v pochve kleshchey. Sarcoptiformes*. Publisher: Nauka, M., 193–196 pp. [in Russian]
- Ermilov, S.G. 2008. *Laboratornoe kul'tivirovanie oribatidnykh kleshchey nadsemeystva Crotonioidea (Acari, Oribatida) s tsel'yu izucheniya ikh razvitiya*. Publisher: Vector TiS, Nizhny Novgorod, 54 pp. [In Russian]
- Grandjean, F. 1953a. Essai de classification des Oribates (Acariens). *Bulletin de la Société zoologique de France*, 78: 421–446.

Table 3.
Development of legs setation of *Banksinoma lanceolata* during ontogeny*

	Trochanter	Femur	Genu	Tibia	Tarsus
Leg I					
Larva	–	d, bv''	$(l), \sigma$	$(l), v', \phi_1$	$(ft), (tc), (p), (u), (a), s, (pv), (pl), e, \omega_1$
Protonymph	–	–	–	–	ω_2
Deutonymph	v'	(l)	–	v'', ϕ_2	–
Tritonymph	–	–	–	–	(it)
Adult	–	v''	–	–	–
Leg II					
Larva	–	d, bv''	$(l), \sigma$	l', v', ϕ	$(ft), (tc), (p), (u), (a), s, (pv), \omega_1$
Protonymph	–	–	–	–	–
Deutonymph	v'	(l)	–	l''	–
Tritonymph	–	–	–	v''	(it)
Adult	–	v''	–	–	–
Leg III					
Larva	–	d, ev'	l', σ	v', ϕ	$(ft), (tc), (p), (u), (a), s, (pv)$
Protonymph	v'	–	–	–	–
Deutonymph	l'	l'	–	v''	–
Tritonymph	–	–	–	l'	(it)
Adult	–	–	–	–	–
Leg IV					
Protonymph	–	–	–	–	$ft'', (p), (u), (pv)$
Deutonymph	–	d, ev'	d, l'	v', ϕ	$(tc), (a), s$
Tritonymph	v'	–	–	l', v''	–
Adult	–	–	–	–	–

*Roman letters refer to normal setae, Greek letters refer to solenidia, e — famulus. One apostrophe (') marks setae on anterior and double apostrophe (") setae on posterior side of the given leg segment. Parentheses refer to a pair of setae. Setae are listed only for the instar in which they first appear.

Grandjean, F. 1953b. Observations sur les Oribates (25^e série). *Bulletin de Muséum*, 25: 155–162.

Grandjean, F. 1964. La solénidiotaxie des Oribates. *Acarologia*, 6: 529–556.

Shaldybina, E.S. 1969. Pancyrnye kleshchi nadsemeystva Ceratozetoidea (ikh morfologiya, biologiya, sistematika i rol' v epizootologii anoplocephalyatozov). The Doctor of Biological Sciences thesis. Gor'kiy, 708 pp. [in Russian]

Shaldybina, E.S. 1971. [About relationship in superfamily Ceratozetoidea]. *Uchenye zapiski gor'kovskogo gosudarstvennogo pedagogicheskogo universiteta*, 116: 72–91. [in Russian]

Subías, L.S. 2009. Listado sistemático, sinonímico y biogeográfico de los ácaros oribátidos (Acariformes: Oribatida) del mundo (excepto fósiles). Originally published in: 2004. *Graellsia*, 60

(número extraordinario): 3–305. Online version actualized in July 2010. 557 pp.; <http://www.ucm.es/info/zoo/Artropodos/Catalogo.pdf>

Travé, J. and Vachon, M. 1975. François Grandjean 1882–1975 (Notice biographique et bibliographique). *Acarologia*, 17: 1–19.

Tuxen, S.L. 1943. Die zeitliche und räumliche Verteilung der Oribatiden-Fauna (Acar.) bei Mälifell, Nord-Island. *Entomologiske Meddelelser*, 23: 321–335.

Weigmann, G. 2006. *Hornmilben (Oribatida)*. Die Tierwelt Deutschlands. 76. Goecke and Evers, Keltern, 520 ss.

Willmann, C. 1931. *Moosmilben oder Oribatiden (Oribatei)*. Die Tierwelt Deutschlands. 22. V.G. Fischer, Jena, 79–200 ss.