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Comparative study of the endemic freshwater fauna of Lake Baikal—III. Phospholipid and fatty acid compositions of the amphipod crustacean of the genus *Eulimnogammarus*

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Lipid and phospholipid, including plasmalogen forms, compositions of three endemic freshwater gammarides, belonging to subphylum Crustacea, genus *Eulimnogammarus* were studied. The fatty acid composition of total lipids, neutral, glyco- and phospholipid fractions were investigated by capillary gas chromatography–mass spectrometry. Ninety-four fatty acids were identified: 26 saturated (both iso-, anteiso- and cyclo-), 31 monoenoic, 11 dienoic, and 26 tri-, tetra-, penta- and hexaenoic. A number of unusual polyunsaturated fatty acids, such as c-9-17:0, c-9-19:0, 5,11,14-20:3, 5,11,14,17-20:4, 24:5(n-6) and 24:6(n-3), were found.

Key words: Lake Baikal; Phospholipids; Fatty acids; *Eulimnogammarus*.

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Introduction

The dominant animals of the Lake Baikal are the amphipods. This Order, Amphipoda, is represented in Baikal by the Family Gammaridae which has developed on an exceptionally large scale; over one third of all gammarid species inhabiting the fresh and marine basins of the world have been described from Baikal. Two hundred and forty species of 34 genera live in Lake Baikal (Bazikalova, 1945; Garaev, 1901). The endemic gammarids of the Family Gammaridae are of special interest to biologists as they have no close relatives in either fresh- or seawater (Bazikalova, 1945). They are interesting objects in terms of lipid biochemistry; their lipid composition, in particular, is very little studied. Czeczuga (1975) studied the carotenoid composition of 13 species of Gammaridae from Lake Baikal.

Marine amphipod lipids have been studied rather intensively with respect to some interesting components such as polyunsaturated fatty acids (Lee, 1975; Morris *et al.*, 1982, 1987; Paradis and Ackman, 1966a,b; Takahashi and Yamada, 1976; Clarke *et al.*, 1985), phospholipids (Dembitsky, 1979; Dembitsky and Vaskovsky, 1976; Vaskovsky, 1989), wax esters (Kayama *et al.*, 1976; Lee, 1974, 1975; Sargent and Lee, 1975; Takahashi and Yamada, 1976), sterols and fatty acids (Fricke and Oehlenschlager, 1988) which are abundant in this Order.

Although the lipid composition of marine crustaceans (Joseph, 1989) is well-documented, there is only a limited amount of information on the lipid composition of the endemic freshwater amphipods.

The present paper deals with the detailed study of fatty acids and lipid compositions of freshwater gammarids living in Lake Baikal.

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Table 1. Lipid composition of freshwater gammarides

Species	NL	GL	PL	TL
Eulimnogammarus cyaneus Dyb.	64.3	6.6	29.1	12.6
Eulimnogammarus verrucosus Gerstf.	57.5	6.2	36.3	6.5
Eulimnogammarus vittatus Dyb.	74.9	5.9	19.2	10.9

Abbreviations: NL, neutral lipids; GL, glycolipids; PL, phospholipids; TL, total lipids, % of dry mass. NL, GL and PL as percent of TL.

Material and Methods

Collection of samples

Eulimnogammarus cyaneus Dyb., *Eulinmogammarus verrucosus Gerstf.*, *Eulimnogammarus vittatus* Dyb., belonging to the Phylum Arthropoda, Subphylum Crustacea, Class Malacostraca, Order Amphipoda, were sampled in the south-western part of Lake Baikal, in July 1992, at depths of 0.5–1.0 m. The animals were immersed in tanks at the site of collection and transported to the laboratory (Biological Station of the Irkutsk University, Bolshye Koty, Russia).

Lipid analysis

The species were treated immediately in the laboratory, as described previously (Dembitsky *et al.*, 1992). Lipids were extracted, separated by column and thin-layer chromatography, as described elsewhere (Dembitsky *et al.*, 1992). Plasmalogen forms of phospholipids were detected by the method of Dembitsky (1988).

Fatty acid ME esters were analysed by capillary gas–liquid chromagraphy–mass spectrometry using a Shimadzu QP-1000 instrument as described previously (Dembitsky *et al.*, 1993).

Results and Discussion

The general lipid compositions from three endemic freshwater gammarids are given in Table 1. According to our results, TL in the gammarids varied from 6.5 to 12.6% dry wt (Table 1). Phospholipid amounts vary from 19.2 in *Eu. vittatus* to 36.3% in *Eu. verrucosus* and the major lipid was NLs and made up 74.9% in *Eu. vittatus.*

Lee (1975) studied lipid compositions of six amphipod species living in Arctic seas near Alaska and found that total lipids varied from 14 in *Hyperia galba* (Feb.) to 40% dry wt in *Pseudalibrotus nanseni* (Oct.). Phospholipid content formed a very high percentage, i.e. 78%, in *Hyperia galba* (Feb.).

Morris (1984) investigated bathypelagic gammarid *Macrohectopus branicki* living in Lake Baikal and found lipid contents of 32.8% dry mass and 47% phospholipids.

In the examined gammarids, the major phospholipid classes were choline-containing lipids which, in gammarids constituted 59.6% in *Eu. vittatus* of the total phospholipid (Table 2); the leader among phospholipids is PC (46.7–48.4%). Sphingomyelin was found in all gammarids, from 4.2 to 5.1%. Sph is reportedly present in all studied marine crustaceans with the maximum amount found in *Ligida cerenascens*, being 9.9% (Kostetsky, 1982). Amine-containing lipids were found to vary from 27.1 to 30.1%; amine phospholipids are represented by PE, plasmalogenic PE, and PS.

Plasmalogens in PE and PC make up over 30% and less than 9%, respectively. Our own data on plasmalogens contained in marine crustaceans (Dembitsky, 1979, 1985) show that the

Table 2. Phospholipid composition of freshwater gammarides

Phospholipid classes		*Eu. cyaneus*	*Eu. verrucosus*	*Eu. vittatus*
Phosphatidylethanolamine	(PE)	15.7 ± 0.5	13.2 ± 0.4	14.6 ± 0.6
Phosphatidalethanolamine (plasmalogen form)	(PEP)	7.1 ± 0.3	9.3 ± 0.4	8.4 ± 0.2
Phosphatidylserine	(PS)	7.3 ± 0.3	4.6 ± 0.2	5.7 ± 0.2
The sum of amine-containing phospholipids		30.1	27.1	28.7
Sphingomyelin	(SPH)	4.4 ± 0.2	4.2 ± 0.1	5.7 ± 0.2
Phosphatidylcholine	(PC)	47.0 ± 0.9	46.7 ± 1.1	48.4 ± 0.8
Phosphatidalcholine (plasmalogen form)	(PCP)	3.7 ± 0.1	4.5 ± 0.1	4.9 ± 0.2
Lyso-PC	(LPC)	—	3.6 ± 0.3	1.2 ± 0.2
The sum of choline-containing phospholipids		55.1	59.0	59.6
Phosphatidylinositol	(PI)	6.5 ± 0.3	6.1 ± 0.2	5.6 ± 0.3
Diphosphatidylglycerol	(DPG)	8.3 ± 0.4	5.2 ± 0.3	6.1 ± 0.4
Phosphatidic acid	(PA)	—	2.6 ± 0.2	—

compounds in question are present in all studied species, their maximum amount in PE, reaching 69.4% in *Cancer amphioetus*, and in PC, reaching 12.2% in *Balanus rostratus*.

Fatty acid composition of amphipods is most interesting. Fatty acids have been studied in marine (Lee, 1975; Clarke *et al.*, 1985; Fricke and Oehlenschlager, 1988) and freshwater amphipod species (Morris *et al.*, 1982, 1987).

We have identified 94 fatty acids, including 26 saturated, 31 monoenoic, 11 dienoic and 26 tri-, tetra-, penta- and hexaneoic acids. Fatty acid composition has been examined both from the total lipid extract (for three amphipod species) and from neutral, glyco- and phospholipid fractions (for two species only).

Among saturated FAs of total lipids, we identified seven *iso*-, four *anteiso*-, and two cyclic acids in all studied species (Table 3). Among monoenoic acids, five families of FAs are worthy of note. Acid 16:1 has three isomers, and 19:1 has four isomers. The families 18:1, 20:1 and 22:1 possess five isomers each. Dienoic acids are invariably interesting in that they contain non-methylene-interrupted (NMI) FAs. These acids were found in large amounts in marine and/or freshwater molluscs (Ackman, 1989; Dembitsky *et al.*, 1992). Our own results point to very moderate levels of NMI FA not exceeding 1%. The presence of these acids in amphipods was identified for the first time. Major of FAs among polyenoic acids are 18:3n-6 (9.79–19.34%), 18:3n-3 (6.04–15.03%) and 20:4n-6 (2.48–8.60%).

GC–MS analysis of the neutral lipid fraction from two amphipod species showed the

Table 3. Fatty acid compositions of total lipids of gammarides

Fatty acids	*Eu. verrucosus*	*Eu. vittatus*	*Eu. cyaneus*
13:0	0.07	0.06	0.05
14:0	2.11	3.61	1.45
15:0	0.22	0.20	0.15
16:0	10.01	10.02	12.56
17:0	0.56	0.13	0.39
18:0	1.89	2.08	7.62
19:0	0.67	0.40	0.46
20:0	1.05	0.22	0.72
22:0	1.78	0.06	1.23
24:0	0.65	0.00	0.60
i-13:0	0.01	0.02	0.01
i-14:0	0.04	0.01	0.03
i-15:0	0.08	0.01	0.06
i-16:0	0.03	0.08	0.02
i-17:0	0.02	0.01	0.01
i-18:0	0.47	0.00	0.32
i-19:0	0.34	0.01	0.23
ai-13:0	0.02	0.04	0.01
ai-15:0	0.10	0.08	0.07
ai-17:0	0.28	0.00	0.19
ai-19:0	0.10	0.16	0.07
c-9-17:0	0.14	0.12	0.10
c-9-19:0	0.49	0.00	0.34
pristanic	0.29	0.19	0.20
phytanic	0.30	0.68	0.21
4,8,12-triMe-13:0	0.33	0.25	0.23
The sum of saturated	22.05	18.44	27.33
The sum of iso-	0.99	0.14	0.68
The sum of anteiso-	0.50	0.28	0.34
The sum of cyclo-	0.63	0.12	0.44
14:1n-7	0.39	0.10	0.27
14:1n-5	0.67	0.06	0.46
16:1n-9	12.89	13.83	10.57
16:1n-7	0.85	0.15	1.16
16:1n-5	0.40	0.00	0.28
17:1n-8	0.16	0.22	0.11
17:1b	0.10	0.00	0.07
18:1n-13	0.16	0.59	0.11
18:1n-11	0.57	2.19	0.39
18:1n-9	15.36	0.32	3.88

Continued

Table 3.—*Continued*

Fatty acids	*Eu. verrucosus*	*Eu. vittatus*	*Eu. cyaneus*
18:1n-7	0.92	0.02	0.63
18:1n-5	0.10	0.25	0.07
19:1b	0.02	0.05	0.01
19:1b	0.03	0.00	0.02
19:1c	0.25	0.00	0.17
19:1n-8	0.09	0.30	0.06
20:1n-15	0.27	0.18	0.19
20:1n-13	0.56	0.69	0.39
20:1n-11	0.19	0.18	0.13
20:1n-9	0.68	0.00	0.47
20:1n-7	0.03	0.02	0.02
21:1b	0.01	0.05	0.01
21:1n-9	0.57	0.59	0.39
22:1n-15	0.19	0.27	0.13
22:1n-13	0.31	0.00	0.21
22:1n-11	0.27	0.37	0.19
22:1n-9	0.31	0.22	0.21
22:1n-7	0.48	0.00	0.06
23:1c	0.01	0.00	0.03
23:1n-9	0.17	0.00	0.23
24:1n-9	0.88	0.00	0.10
The sum of monoenoic	37.89	20.65	21.02
16:2n-4	0.34	0.90	0.23
18:2n-9	0.83	0.60	11.91
18:2n-6	7.67	7.38	0.57
18:2b	0.07	0.00	0.05
18:2b	0.19	0.44	0.13
5,11–20:2	0.35	0.29	0.24
5,13–20:2	0.08	0.06	0.06
20:2n-9	0.55	0.56	0.38
20:2n-6	0.16	0.38	0.11
7,13–22:2	0.09	0.25	0.06
7,15–22:2	0.30	0.00	0.31
The sum of dienoic	10.63	10.86	14.05
16:3n-4	0.76	0.96	0.52
16:3n-6	0.78	1.51	2.97
18:3n-6	9.79	19.34	13.64
18:3n-3	8.77	15.03	6.04
20:3n-9	0.43	0.25	0.30
5,11,14–20:3	0.39	0.00	0.27
20:3n-6	0.07	0.20	0.05
20:3n-3	0.37	1.04	0.25
22:3n-9	0.06	0.08	0.04
22:3n-6	0.22	0.41	0.15
16:4n-1	1.21	1.11	1.99
18:4n-3	0.11	0.11	0.08
20:4n-6	2.48	4.06	8.60
5,11,14,17–20:4	0.59	0.00	0.41
20:4n-3	0.11	0.43	0.08
22:4n-6	0.10	0.27	0.07
22:4n-3	0.24	0.94	0.17
24:4n-6	0.38	0.18	0.26
18:5n-3	0.33	0.00	0.23
20:5n-3	0.07	0.34	0.05
21:5n-3	0.01	0.00	0.01
22:5n-6	0.11	0.26	0.17
22:5n-3	1.16	1.84	0.80
24:5n-6	0.44	0.69	0.14
22:6n-3	0.11	0.22	0.08
24:6n-3	0.34	0.78	0.23
The sum of tri-, tetra-, penta- and hexaenoic	29.43	50.05	37.60

Abbreviations: i, iso-, ai, anteiso-, c, cyclopropanoic ring.
a: identified only on the basis retention time and mass spectrum of methyl ester.
b: fatty acids probably with cyclopropanoic ring(s).
c: unknown position of double bond(s), identified by retention time and value of molecular ion of methyl ester.

Table 4. Fatty acid composition of neutral lipids from gammarides

Fatty acids	*Eu. verrucosus*	*Eu. vittatus*
13:0	0.23	0.22
14:0	9.92	7.69
15:0	0.52	0.51
16:0	22.04	13.00
17:0	1.15	1.14
18:0	9.25	15.83
19:0	1.70	1.68
20:0	2.30	2.27
22:0	5.56	5.51
24:0	1.45	1.44
i-13:0	0.01	0.01
i-14:0	0.18	0.18
i-15:0	0.40	0.39
i-16:0	0.41	0.40
i-17:0	0.05	0.05
i-18:0	0.73	0.72
i-19:0	0.56	0.55
ai-13:0	0.08	0.07
ai-15:0	0.56	0.55
ai-17:0	0.10	0.10
ai-19:0	0.13	0.13
c-9-17:0	0.88	0.87
c-9-19:0	0.26	0.26
pristanic	0.28	0.28
phytanic	0.81	0.80
4,8,12-triMe-13:0	0.97	0.96
The sum of saturated	60.53	55.61
The sum of iso-	2.34	2.30
The sum of anteiso-	0.87	0.85
The sum of cyclo-	1.14	1.13
14:1n-7	0.27	0.27
14:1n-5	0.41	0.40
16:1n-9	13.28	18.44
16:1n-7	1.29	1.28
16:1n-5	0.38	0.37
17:1n-8	0.16	0.16
17:1b	0.03	0.03
18:1n-13	0.09	0.09
18:1n-11	0.39	0.38
18:1n-9	16.67	16.50
18:1n-7	1.07	1.06
18:1n-5	0.18	0.18
19:1b	0.01	0.01
19:1c	0.15	0.15
20:1n-15	0.26	0.26
20:1n-13	0.10	0.10
22:1n-11	0.14	0.14
20:1n-9	0.41	0.40
21:1n-9	0.10	0.10
22:1n-15	0.13	0.13
22:1n-13	0.09	0.09
22:1n-11	0.03	0.03
22:1n-9	0.04	0.04
22:1n-7	0.09	0.09
23:1n-9	0.02	0.02
24:1n-9	0.02	0.02
24:1n-9	0.08	0.07
The sum of monoenoic	35.87	40.79
18:2n-9	0.13	0.13
18:2n-6	0.39	0.38
18:2b	0.01	0.01
The sum of dienoic	0.53	0.52
18:3n-6	2.08	2.05
18:3n-3	0.93	0.97
20:4n-6	0.06	0.06
The sum of polyenoic	3.07	3.08

a, b and c: see footnote in Table 3 for explanation.

domination of saturated fatty acids, 60.53% in *Eu. verrucosus* and 55.61% in *Eu. vittatus* (Table 4). We identified a high percentage of *iso*- (2.34 and 2.30%, respectively) and *cyclo*- (1.14 and 1.13%). The cyclopropanoic acids in endemic amphipods were identified for the first time.

Polyenoic acids including tri-, tetra-, penta- and hexaenoic acids are basically concentrated in glyco- and phospholipid fractions at a level over 40% (Tables 5 and 6). Amounts of

Table 5. Fatty acid compositions of phospholipids of gammarides

Fatty acid	*Eu. verrucosus*	*Eu. vittatus*
13:0	0.04	0.03
14:0	1.48	1.32
15:0	0.18	0.16
16:0	6.74	3.80
17:0	0.10	0.09
18:0	0.87	0.78
19:0	0.18	0.16
20:0	0.45	0.40
22:0	0.24	0.22
24:0	0.19	0.17
i-14:0	0.02	0.02
i-15:0	0.05	0.05
i-18:0	0.09	0.08
i-19:0	0.05	0.05
ai-13:0	0.01	0.01
ai-15:0	0.04	0.03
ai-17:0	0.01	0.01
ai-19:0	0.09	0.08
c-9-17:0	0.21	0.18
c-9-19:0	0.01	0.01
pristanic	0.02	0.02
phytanic	0.02	0.02
4,8,12-triMe-13:0	0.17	0.15
The sum of saturated	11.26	7.84
The sum of iso-	0.21	0.20
The sum of anteiso-	0.15	0.13
The sum of cyclo-	0.22	0.19
14:1n-7	0.53	0.47
14:1n-5	0.65	0.58
16:1n-9	7.12	12.91
16:1n-7	1.13	1.01
16:1n-5	0.47	0.41
17:1n-8	0.18	0.16
17:1b	0.04	0.03
18:1n-13	0.24	0.21
18:1n-11	0.70	0.62
18:1n-9	10.04	5.64
18:1n-7	0.95	0.84
18:1n-5	0.16	0.14
19:1c	0.15	0.13
19:1b	0.01	0.01
19:1b	0.01	0.01
19:1n-8	0.10	0.09
20:1n-15	0.28	0.25
20:1n-13	0.76	0.68
20:1n-11	0.26	0.23
20:1n-9	0.94	0.84
20:1n-7	0.07	0.06
21:1n-9	0.71	0.63
22:1n-15	0.24	0.21
22:1n-13	0.41	0.37
22:1n-11	0.28	0.25

Continued

Table 5.—*Continued*

Fatty acid	*Eu. verrucosus*	*Eu. vittatus*
22:1n-9	0.33	0.30
22:1n-7	0.63	0.56
23:1n-9	0.09	0.08
24:1n-9	0.94	0.84
The sum of monoenoic	28.42	28.56
16:2n-4	0.34	0.30
18:2n-9	0.19	0.17
18:2n-6	14.31	16.68
18:2b	0.02	0.02
5,11–20:2	0.25	0.22
5,13–20:2	0.30	0.27
20:2n-9	0.56	0.50
20:2n-6	0.24	0.21
7,13–22:2	0.12	0.11
7,15–22:2	0.36	0.32
The sum of dienoic	16.69	18.80
16:3n-4	0.29	0.26
16:3n-6	1.44	1.28
18:3n-6	14.15	17.34
18:3n-3	12.51	4.55
20:3n-9	0.50	0.45
5,11,14–20:3	0.66	0.59
20:3n-6	0.10	0.39
20:3n-3	0.86	0.36
22:3n-9	0.09	0.08
22:3n-6	0.53	0.47
16:4n-1	1.38	1.22
18:4n-3	0.17	0.15
20:4n-6	5.49	12.07
5,11,14,17–20:4	0.73	0.65
20:4n-3	0.23	0.27
22:4n-6	0.16	0.14
22:4n-3	0.27	0.24
24:4n-6	0.47	0.42
18:5n-3	0.43	0.38
20:5n-3	0.10	0.09
21:5n-3	0.01	0.01
22:5n-6	0.13	0.12
22:5n-3	1.78	2.24
24:5n-6	0.38	0.34
22:6n-3	0.31	0.28
24:6n-3	0.46	0.41
The sum of tri-, tetra-, penta- and hexaenoic	43.63	44.80

a,b,c: see footnote in Table 3 for explanation.

Table 6. Fatty acid compositions of glycolipids from gammarides

Fatty acid	*Eu. verrucosus*	*Eu. vittatus*
14:0	0.89	0.84
15:0	0.13	0.12
16:0	5.56	2.77
17:0	0.05	0.05
18:0	0.64	0.61
19:0	0.24	0.22
20:0	0.20	0.19
22:0	0.17	0.16
24:0	0.14	0.13
i-14:0	0.01	0.01
i-15:0	0.10	0.10
i-18:0	0.06	0.06
i-19:0	0.07	0.06
ai-15:0	0.05	0.05
ai-17:0	0.39	0.37
ai-19:0	0.08	0.07
c-9-17:0	0.04	0.04
c-9-19:0	0.47	0.45
pristanic	0.08	0.07
phytanic	0.27	0.25
4,8,12-triMe-13:0	0.09	0.09
The sum of saturated	9.73	6.71
The sum of iso-	0.24	0.23
The sum of anteiso-	0.52	0.49
The sum of cyclo	0.51	0.49
14:1n-7	0.53	0.50
14:1n-5	0.68	0.64
16:1n-9	10.68	16.33
16:1n-7	1.11	1.05
16:1n-5	0.49	0.46
17:1n-8	0.20	0.19
17:1b	0.31	0.29
18:1n-13	0.18	0.17
18:1n-11	0.47	0.44
18:1n-9	15.61	6.10
18:1n-7	0.77	0.73
18:1n-5	0.10	0.09
19:1b	0.18	0.17
19:1b	0.15	0.14
19:1c	0.12	0.11
19:1n-8	0.06	0.06
20:1n-15	0.27	0.25
20:1n-13	0.59	0.56
20:1n-11	0.28	0.27
20:1n-9	1.60	1.76
20:1n-7	0.04	0.04
21:1b	0.64	0.61
21:1n-9	0.40	0.38
22:1n-15	0.27	0.25
22:1n-13	0.31	0.30
22:1n-11	0.54	0.52
22:1n-9	0.35	0.34
22:1n-7	0.44	0.42
23:1c	0.18	0.17
23:1n-9	0.21	0.20
24:1n-9	1.13	1.07
The sum of monoenoic	38.89	34.61
16:2n-4	0.41	0.39
18:2n-9	0.86	0.81
18:2n-6	9.41	15.11
18:2b	0.12	0.12
18:2b	0.41	0.39
5,11–20:2	0.34	0.32
5,13–20:2	0.09	0.09
20:2n-9	0.57	0.54
20:2n-6	0.15	0.14
7,13–22:2	0.12	0.12
7,15–22:2	0.41	0.39
The sum of dienoic	12.89	18.42
16:3n-4	0.61	0.58
16:3n-6	1.04	0.99
18:3n-6	9.78	15.34
18:3n-3	12.86	5.97
20:3n-9	0.44	0.42
5,11,14–20:3	0.71	0.67
20:3n-6	0.12	0.12
20:3n-3	0.55	0.52
22:3n-9	0.59	0.56
22:3n-6	0.26	0.24
16:4n-1	0.99	0.94
18:4n-3	0.20	0.19
20:4n-6	3.95	7.91
5,11,14,17–20:4	0.78	0.74
20:4n-3	0.26	0.24
22:4n-6	0.11	0.11
22:4n-3	0.62	0.58

Continued

Table 6.—*Continued*

Fatty acid	*Eu. verrucosus*	*Eu. vittatus*
24:4n-6	0.54	0.51
18:5n-3	0.56	0.53
20:5n-3	0.15	0.14
21:5n-3	0.01	0.01
22:5n-6	0.16	0.15
22:5n-3	2.24	1.84
24:5n-6	0.26	0.25
22:6n-3	0.16	0.19
24:6n-3	0.54	0.52
The sum of tri-, tetra-, penta-, and hexaenoic	38.49	40.26

a,b and c: see footnote in Table 3 for explanation.

arachidonic acid were found in higher percentages in phospholipid (5.49 and 12.07%) and glycolipid (3.95 and 7.91%) fractions, respectively. The major FAs in glyco- and phospholipid fractions were the following acids: two isomers of 18:3, namely (n-6) and (n-3); and arachidonic acids (including all isomers).

Marine Antarctic amphipods *Themisto gaudichaudii* contained extremely high contents of eicosapentaenoic (21.1%) and docosahexaenoic (15.9%) acids (Fricke and Oehlenschlager, 1988), and very small or undetectable levels of arachidonic acid in total fatty acids. High levels of docosahexaenoic (27.2%) and eicosapentaenoic (15.5%) acids were found in phospholipids of freshwater baikalian gammarid *Macrohectopus branicki* (Morris, 1984). We found the content of 22:6n-3 (0.31 and 0.28%) and 20:5n-3 (0.10 and 0.09% from two species, respectively, see Table 5).

Morris *et al.* (1982) reported interesting data for the acclimated freshwater amphipod *Gammarus duebeni* to seawater. The level of eicosapentaenoic acid to increase from 6% (field controls) to 23% (100% seawater, 60 days acclimated) in gill phospholipids; and decrease to 6.7% (100% seawater, 66 days) after acclimation of the animals to different salinities.

Thus, our study into the lipids from three amphipod species has demonstrated that the animals in question contain a large variety of fatty acids, some of which belong to a number of rarely occurring ones, namely 5,11,14–20:3, 5,11,14,17–20:4, 24:4n-6, 24:5n-6, 24:6n-3, and were established for the first time for amphipod crustaceans, namely cyclopropanoic acids and NMI FAs.

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