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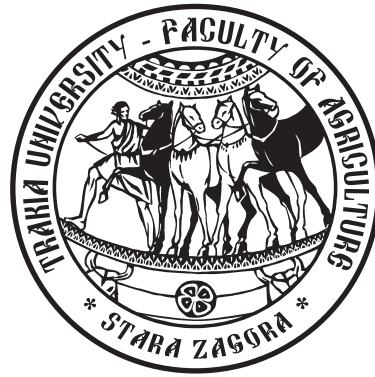
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Distribution of the black mussel *Mytilus galloprovincialis* (L.) along the Bulgarian Black Sea coast

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Abstract. The authors present data from studies of black mussels (*Mytilus galloprovincialis*) along the Bulgarian Black Sea coast. There were performed a total of 73 trawls in 6 mussel fields - Balchik, Galata, Byala, Emine, St. Vlas and Cape Maslen. The paper presents the data for size composition of the mussel in the separate fields, the amount yield per unit effort (15 minutes trawling) and the total stock of the fields equal to 92,482 tons. A comparison between different fields shows that the richest field is this in front of cape Emine. As a result of research it was found uneven distribution of the species in fields, as evidenced by fluctuations in the amount yields and the presence of empty trawlers.

Keywords: Black Sea, black mussel (*Mytilus galloprovincialis*), stock assessment

Introduction

The black mussel *Mytilus galloprovincialis* is the most common bivalve along the Bulgarian Black Sea coast. In open sea areas it can be found to 65 meters and in shallow waters to 15-20 meters. It is one of the leading species in biocenosis of *Mytilus* mud. The maximum size of mussel reached 12-13 centimeters. The sizes in the catches vary from 4-5 to 7-8 cm. The correlation between the separate parts of the body is: meat 15 - 20 %, shell - 35 - 45 %, mantle liquid - 35 - 45 %. The chemical composition of the mussel according to Abliamitova- Vinogradova (1949) is as follows: water- 86.76 %, proteins - 7.31 %, carbohydrate - 3.55 %, fat - 0.78 %, mineral matters - 1.6 %.

The black mussel is an active filter for the sea waters. Depending of the size of the body, one individual can filter up to 25 liters per day, retaining nutrients and disposing of contaminants in it. The usage of this species for food and its participation in self-cleaning processes in the sea determine the interest of many researchers related to the biology and stock assessment in Black Sea (Brayko et al., 1959; Ivanov, 1963, 1965).

The first quantity investigations of *Mytilus galloprovincialis* were performed in 1926 from Dutch vessel "Kniper" from river Batova mouth to the Turkish border. Concrete quantitative data are not given unless the remark that the richest catches are made between Batova River and Cape Emine in comparison with those carried out between cape Emine and cape Maslen. Later Nechaev and Chernev (1938) make such studies giving the quantity of mussels along our coast amounting to 100,000 tons. The most thorough studies on the quantity and distribution of black mussels are found in the work of Kuneva-Abadjieva and Marinov (1967). In the study only the characteristic of the different fields can be found but the authors also calculate the total stock of species amounting to around 300,000 tons. After the invasion of the predatory snail *Rapana venosa* and water pollution in the 1970s the mussel fields are strongly reduced, and in some places completely destroyed. The export of meat of this snail leads to intensive usage and balancing the quantities of both species. As a result, the mussel fields were recovered.

The objective of this study was to establish of a mussel stock after *Rapana venosa* invasion, to determine the black mussel

distribution along the Bulgarian Black Sea coast and to make recommendations for possible catches of the species without undermining its stock

Material and methods

The trawling activities were made in 2005 between cape Kaliakra and cape Maslen with R/V "Rusano" and R/V № 37 along the Bulgarian Black Sea coast. There have been a total of 73 trawls lasting 15 minutes. The size composition of the mussels (length and width) was determined by means of a Shubler calliper on the shipboard as well their weight in each trawl. The estimating of the stock was performed by the methods of areas. The trawling activities were performed in six mussel fields at depths 16-55 meters. The results for the different mussel fields are shown below.

Results and discussion

Characterization of the field in front of Balchik

The field is located south of the Albena resort and reaches the eastern coast of Kavarna. Trawling is done at depths of 16 to 20 meters in *Mytilus* biocenose. The sediment is mud and fine sand. 15 trawls were made, the results of which can be seen at Table 1. Data show that the mussel field is restored. There are variations in the quantities (from empty trawls to maximum catch of 400 kg) due to the spotty distribution of *M. galloprovincialis*. The sizes of the clams vary from 3.0 to 9.0 cm, the average length is equal to 5.89 cm. Graphic expression of the size composition of the mussels of this field is presented in Figure 1 and 2 as individual cases (trawl VI and XII). The number of additional species is 12, with a predominance of mollusks, followed by crustaceans. The *Rapana* yield per unit effort was 20 kg.

Characterization of the field in front of cape Galata

The field is located north of "Sv. Konstantin and Elena" resort and south of cape Galata in depths 17-24 meters. The sediment is mud mixed with fine sand. There were performed 14 dredging and the results are shown on Table 2. The mussel yield per unit effort (15

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Table 1. Results from trawling activities for black mussel in field "Balchik"

Trawl	Depth	Mussels / yield/kg	Size (cm)	MI	Additional species
1	20	-	-	-	-
2	19	-	-	-	-
3	18	-	-	-	3
4	18	-	-	-	3
5	17.5	-	-	-	3
6	17	40	3.0-8.0	6.09	7
7	16	40	3.0-7.5	6.04	5
8	16	240	3.5-9.0	5.83	6
9	17	120	3.5-8.5	6.01	7
10	17	400	3.5-8.0	5.50	5
11	17	200	3.5-8.0	5.87	5
12	17.6	220	3.0-8.5	5.49	7
13	19	200	3.5-8.0	6.03	7
14	19	200	3.5-8.5	5.89	4
15	19.5	160	3.5-8.5	6.13	6

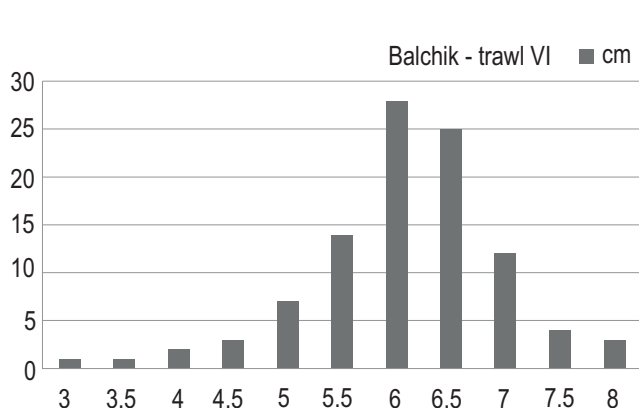


Figure 1. Size composition of *M. galloprovincialis* – mussel field "Balchik", VI trawl Size composition = 3.0-8.0 cm, average length (M) = 6.09 cm, yield = 40 kg

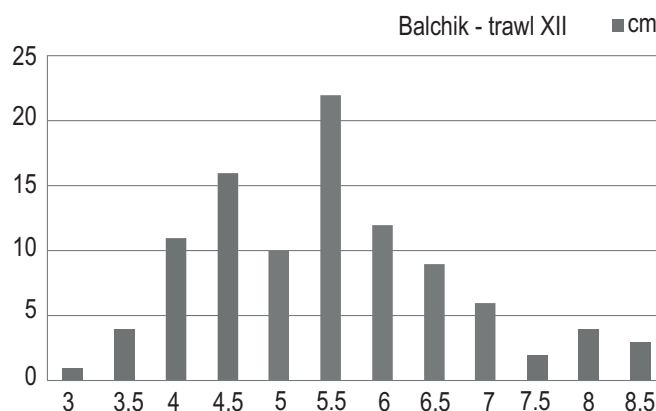


Figure 2. Size composition of *M. galloprovincialis* – mussel field "Balchik", XII trawl Size composition = 3.0-8.5 cm, average length (M) = 5.49 cm, yield = 220 kg

minutes) varies from 40 to 900 kg. The size composition varies from 3.5 to 10 cm, the average length is 6.20 cm. The additional species in the catches are 16 and vary from 4 to 10. The *Rapana* yield per unit effort was 40 kg.

The small depths, which remain at large distances from the shore, determine the specific bottom conditions. This allows the development of *Mytilus biocenos* of a large area. Leading species – *M. galloprovincialis* found the same conditions for development. Confirmation of this is the homogeneous size of mussels in various parts of the field (Figure 3 and 4).

Characterization of the field in front of Byala

The field is located north of Pasha Dere and south of cape Cherni. The field is located entirely in *Mitylus biocenos* and the sediment is mud. There were performed 16 dredging in depths 21-30 meters and the results are shown on Table 3. The mussel yield per unit effort (15 minutes) varies from 160 to 600 kg. The additional species in the catches are 11. The size composition varies from 3.0 to 8.5 cm; the average length is 5.89 cm (Figure 5 and 6).

Characterization of the field in front of cape Emine

The field is located at limits: on the north of cape St. Atanas and to the south of cape Emine. There were performed 6 dredging in depths 18-40 meters (Table 4). The sediment is mud with many *Mytilus* shells in destruction process. The mussel yield per unit effort (15 minutes) varies from 40 to 740 kg and the number of additional species was 16. The size composition varies from 3.5 to 8.5 cm; the average length is 5.62 cm (7 and 8). Based on catches in the mussel field we can make conclusion that this field is the richest of the surveyed fields.

Characterization of the field in front of St. Vlas

This field is located east to cape Emine and west of Sv. Vlas in depths 17-27 m. The sediment is mud. Total 11 trawls were made (Table 5). The field is clear, comfortable for work. The yield per unit effort is in limits from 0 to 500 kg. Empty trawls are established in the west part of the field. The additional species vary from 3 to 12. The size composition varies from 2.0 to 9.0 cm (Figure 9 and 10).

Table 2. Results from trawling activities for black mussel in field "Galata"

Trawl	Depth	Mussels / yield/kg	Size (cm)	MI	Additional species
1	20	-	-	-	-
2	19	-	-	-	-
3	18	-	-	-	3
4	18	-	-	-	3
5	17.5	-	-	-	3
6	17	40	3.0-8.0	6.09	7
7	16	40	3.0-7.5	6.04	5
8	16	240	3.5-9.0	5.83	6
9	17	120	3.5-8.5	6.01	7
10	17	400	3.5-8.0	5.50	5
11	17	200	3.5-8.0	5.87	5
12	17.6	220	3.0-8.5	5.49	7
13	19	200	3.5-8.0	6.03	7
14	19	200	3.5-8.5	5.89	4
15	19.5	160	3.5-8.5	6.13	6

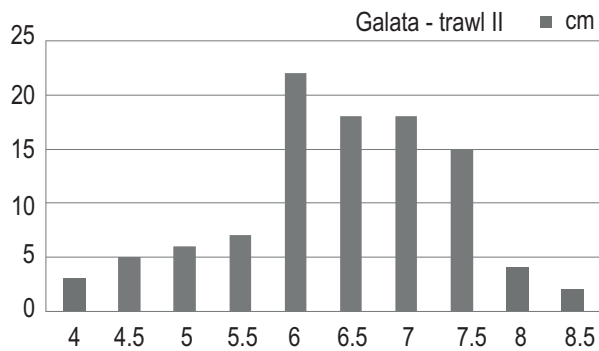


Figure 3. Size composition of *M. galloprvinctialis* – mussel field "Galata", II trawl Size composition = 4.0-8.5 cm, average length (M) = 6.40 cm, yield = 300 kg

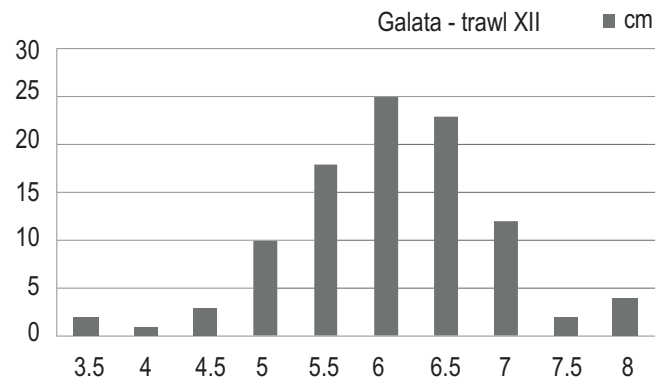


Figure 4. Size composition of *M. galloprvinctialis* – mussel field "Galata", XII trawl Size composition = 3.5-8.0 cm, average length (M) = 6.04 cm, yield = 400 kg

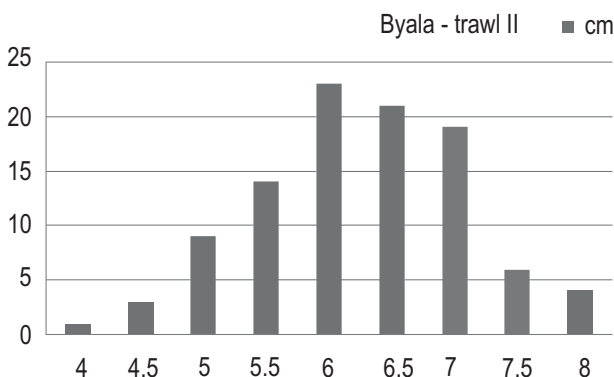


Figure 5. Size composition of *M. galloprvinctialis* – mussel field "Byala" – II trawl Size composition = 4.0-8.0 cm, average length (M) = 6.24 cm, yield = 160 kg

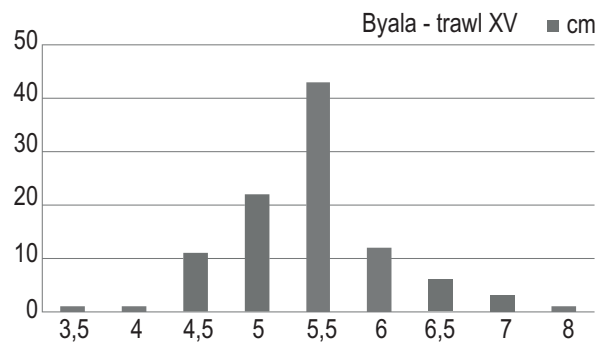


Figure 6. Size composition of *M. galloprvinctialis* – mussel field "Byala", XV trawl Size composition = 3.0-7.0 cm, Average length (M) = 4.93 cm, Yield = 200 kg

Characterization of the field in front of cape Maslen

The field is located within the north of cape Kolokita and south of the town of Kiten. The field falls in *Mitylus* biocenosis and the

sediment is mud. Eleven trawls were made in depths 23-55 m (Table 6). The data indicate recovery of the field established by Kuneva-Abadjieva and Marinov (1967). The fluctuations in the catches show

Table 3. Results from trawling activities for black mussel in field "Byala"

Trawl	Depth	Mussels / yield/kg	Size (cm)	MI	Additional species
1	21	160	4.0-7.5	6.14	7
2	22	160	4.0-8.0	6.24	5
3	23	200	3.5-8.5	5.88	8
4	24	500	3.5-8.5	5.78	7
5	25	200	4.0-8.0	6.05	4
6	26	400	4.0-8.0	6.21	9
7	25	500	4.0-8.5	5.98	4
8	25	-	-	-	-
9	25	440	5.0-8.0	6.23	7
10	24	500	3.5-8.0	6.03	9
11	24	500	3.0-7.5	5.99	4
12	23	500	4.0-8.0	5.96	5
13	23	400	4.0-8.0	6.15	8
14	22	300	4.5-8.5	6.11	5
15	35	200	3.0-7.0	4.93	10
16	35	600	3.5-6.5	4.68	11

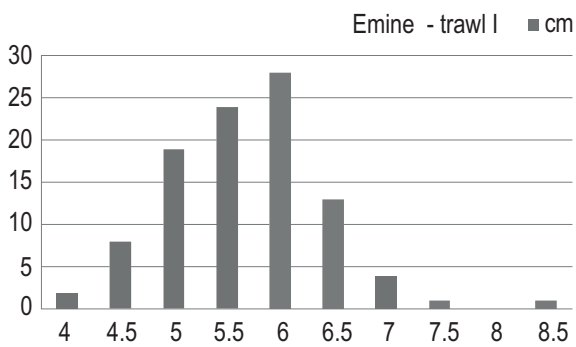


Figure 7. Size composition of *M. galloprovincialis* – mussel field "Emine", I trawl Size composition = 4.0-8.5 cm, average length (M) = 5.67 cm, yield = 500 kg

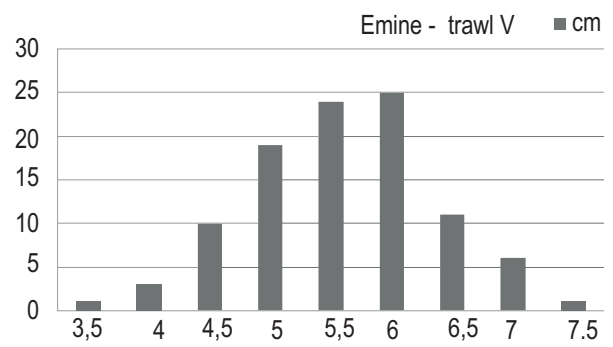


Figure 8. Size composition of *M. galloprovincialis* – mussel field "Emine", V trawl Size composition = 3.5-7.5 cm, average length (M) = 5.58 cm, yield = 40 kg

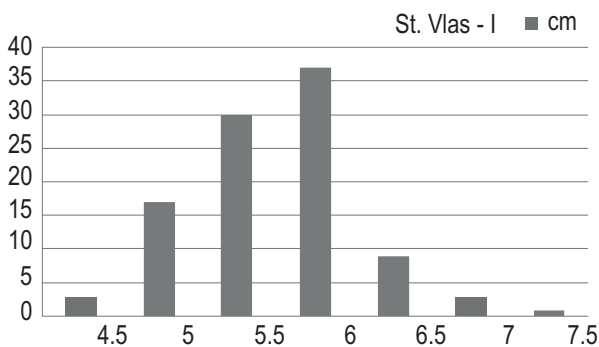


Figure 9. Size composition of *M. galloprovincialis* – mussel field "St. Vlas", I trawl Size composition = 4.0-7.5 cm, average length (M) = 5.72 cm, yield = 280 kg

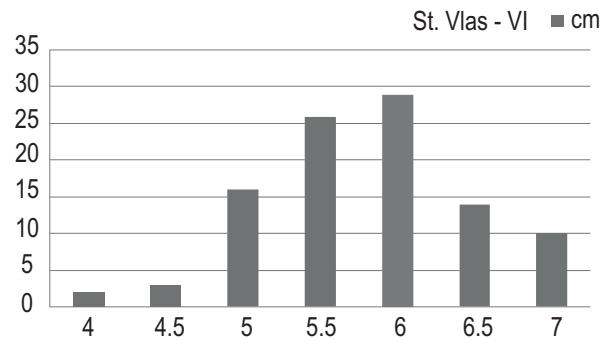


Figure 10. Size composition of *M. galloprovincialis* – mussel field "St. Vlas", VI trawl Size composition = 4.0-7.5 cm, average length (M) = 5.91 cm, yield = 60 k

Table 4. Results from trawling activities for black mussel in field "Emine"

Trawl	Depth	Mussels / yield/kg	Size (cm)	MI	Additional species
1	40	500	4.0-8.5	5.67	5
2	30	740	4.0-7.0	5.6	6
3	18	200	4.0-7.5	5.64	5
4	32	200	4.0-8.0	5.89	6
5	38	40	3.5-7.5	5.58	6
6	38	200	3.5-7.5	5.35	10

Table 5. Results from trawling activities for black mussel in field "St. Vlas"

Trawl	Depth	Mussels / yield/kg	Size (cm)	MI	Additional species
1	23	280	4.5-7.5	5.72	6
2	27	400	4.0-8.0	6.01	8
3	23	500	2.0-7.5	5.75	3
4	22	40	4.5-7.5	5.91	6
5	23	40	4.5-7.5	5.85	4
6	24	400	4.0-7.0	5.79	4
7	25	-	-	-	-
8	23	40	4.0-9.0	6.29	4
9	19	-	-	-	6
10	17	-	-	-	3
11	23	60	4.0-7.5	5.91	7

Table 6. Results from trawling activities for black mussel in field "cape Maslen"

Trawl	Depth	Mussels / yield/kg	Size (cm)	MI	Additional species
1	43	30	3.0-8.0	5.54	8
2	40	300	4.0-8.5	5.87	5
3	-	-	-	-	-
4	-	-	-	-	-
5	50	80	3.5-7.0	5.07	8
6	55	180	3.5-6.5	5.15	5
7	49	180	4.0-7.0	5.42	3
8	40	80	4.0-9.5	5.96	12
9	38	120	4.0-10.0	6.15	7
10	23	-	-	-	5
11	37	280	4.5-8.5	6.18	8

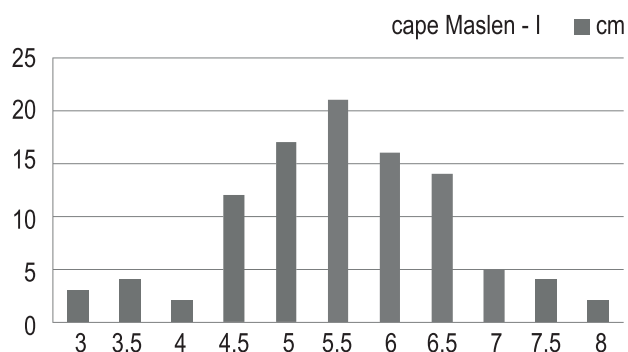


Figure 11. Size composition of *M. galloprovincialis* – mussel field "cape Maslen", I trawl Size composition = 3.0-8.0 cm, average length (M) = 5.54 cm, yield = 30 kg

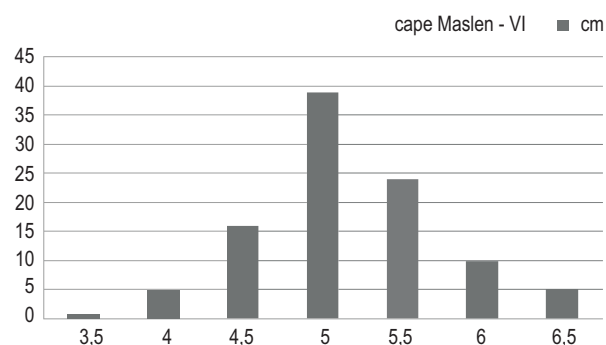


Figure 12. Size composition of *M. galloprovincialis* – mussel field "cape maslen", VI trawl Size composition = 3.5-6.5 cm, average length (M) = 5.15 cm, yield = 180 kg

spot-like distribution of the mussels in the field. The mussel yield per unit effort (15 minutes) varies from 0 to 300 kg. The size composition varies from 5.07 to 6.18 cm (Figure 11 and 12). In the entire field mussels are uniform in size composition. The highest percentage of mussels is with size 5.0-5.5 cm. The recovering of the field is due to the good food base in this area (Nikolov et al., 2010).

Conclusion

The main mussel fields along the Bulgarian Black Sea coast are in good condition after passed destructive effects caused by *Rapana* and eutrophication of waters in the 1970s and 1980s. The richest mussel field is the one in front of cape Emine followed by those in front of Byala and cape Maslen. The total biomass of the mussels in the studied fields is set at 92,482 tones. The additional species vary from 13 (Balchik) to 25 (Byala), including widespread animals. Between them there are no rare or endangered species.

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Instruction for authors

Preparation of papers

Papers shall be submitted at the editorial office typed on standard typing pages (A4, 30 lines per page, 62 characters per line). The editors recommend up to 15 pages for full research paper (including abstract, references, tables, figures and other appendices)

The manuscript should be structured as follows: Title, Names of authors and affiliation address, Abstract, List of keywords, Introduction, Material and methods, Results, Discussion, Conclusion, Acknowledgements (if any), References, Tables, Figures.

The title needs to be as concise and informative about the nature of research. It should be written with small letter /bold, 14/ without any abbreviations.

Names and affiliation of authors

The names of the authors should be presented from the initials of first names followed by the family names. The complete address and name of the institution should be stated next. The affiliation of authors are designated by different signs. For the author who is going to be corresponding by the editorial board and readers, an E-mail address and telephone number should be presented as footnote on the first page. Corresponding author is indicated with *.

Abstract should be not more than 350 words. It should be clearly stated what new findings have been made in the course of research. Abbreviations and references to authors are inadmissible in the summary. It should be understandable without having read the paper and should be in one paragraph.

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Todorov N and Mitev J, 1995. Effect of level of feeding during dry period, and body condition score on reproductive performance in dairy cows, IXth International Conference on Production Diseases in Farm Animals, Sept.11 – 14, Berlin, Germany, p. 302 (Abstr.).

Thesis:

Penkov D, 2008. Estimation of metabolic energy and true digestibility of amino acids of some feeds in experiments with muscovy duck (*Carina moschata*, L). Thesis for DSc. Agrarian University, Plovdiv, 314 pp.

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