Науковий вісник Львівського національного університету ветеринарної медицини та біотехнологій імені С.З. Ґжицького
Scientific Messenger of Lviv National University of Veterinary Medicine and Biotechnologies named after S.Z. Gzhytskyj

doi:10.15421/nvlvet6814

ISSN 2413–5550 print
ISSN 2518–1327 online

http://nvlvet.com.ua/

UDC 638.178.2–138

Morphological characteristics of bee pollen obtained from *Brassica napus* L.

N.M. Redina[1], L.O. Adamchuk[1], N.V. Nikolaieva[2], J. Brindza[2]
redina234@ukr.net, leonora.adamchuk@gmail.com, n.nikolaeva703@gmail.com, brindza.jan@gmail.com

[1]National University of Life and Environmental Sciences of Ukraine,
Heroyiv Oborony Str., 11, Kyiv, 03041, Ukraine;
[2]Slovak University of Agriculture in Nitra,
Tr. A. Hlinku 2, 949 76, Nitra, Slovakia

The purpose of this work was to research the morphological characteristics of monofloral bee pollen obtained from Brassica napus L. The formulated goals were: determine the period of bee pollen receiving; implement the selection of bee pollen samples during blooming period of species; establish the monoflorality ratio of the total pollen collection; explore the morphometric indicators of bee pollen by the parameters of pollen lump, shaping level and weight. Bee pollen collection was carried out in Skvyra district of Kyiv region from local population of Apis mellifera L. families. Morphometric measurements were performed in the Institute of Biodiversity Conservation and Biosafety, Slovak University of Agriculture in Nitra. Here were determined the amount of bee pollen per one day brought by one family: from 27.04 to 03.05.16 is 50.8 ± 2.25 g; from 04.05 to 06.05.16 – 100.0 ± 3.33 g; from 07.05 to 17.05.16 – 270.7 ± 11.79 g; from 18.05 to 22.05.16 – 100.5 ± 3.028 g; from 23.05 – 25.05.16 – 39.8 ± 2.74 g. Here were defined the morphological parameters of bee pollen lump from B. napus: length is in the range from 3.40 ± 0.061 mm to 3.66 ± 0.048 mm; width is in the range from 2.88 ± 0.059 mm to 3.26 ± 0.067 mm; weight is in the range from 8.65 ± 0.317 mg to 11.31 ± 0.241 mg; shaping level of bee pollen is in the range 4.62 – 4.96 points. The total monoflorality ratio constitutes from 79.94 ± 0.619 % to 98.00 ± 0.202 %. The obtained results confirmed that the activity of bee flying depends on the blooming period and intensity of the nectar secretion, on the collection of protein feed from B. napus. Pollen lumps from Brassica napus L. bee pollen were large, dense, regular shape without splits, which specified the possibility of its use for the producing on a commercial scale.

Key words: *bee pollen, pollen lump, monoflorality ratio, shaping level, Brassica napus L., morphological parameters.*

Морфологічна характеристика бджолиного обніжжя одержаного з *Brassica napus* L.

Н.М. Редіна[1], Л.О. Адамчук[1], Н.В. Ніколаєва[2], Я. Бріндза[2]
redina234@ukr.net, leonora.adamchuk@gmail.com, n.nikolaeva703@gmail.com, brindza.jan@gmail.com

Національний університет біоресурсів і природокористування України,
вул. Героїв Оборони, 11, м. Київ, 03041, Україна;
Словацький аграрний університет в Нітрі, Нітра, Словаччина

Метою роботи було дослідження морфологічної характеристики монофлорного бджолиного обніжжя одержаного з Brassica napus L. Поставлені завдання: встановити період одержання бджолиного обніжжя; здійснити відбір бджолиного обніжжя продовж цвітіння виду; встановити монофлорність загального збору обніжжя; дослідити морфометричні показники обніжжя за параметрами пилкової грудочки, сформованістю та масою. Відбір обніжжя здійснювали у Сквирському районі Київської області від сімей Apis mellifera L. місцевої популяції. Морфометричні вимірювання проводили в Інституту збереження агробіорізноманіття та біологічної безпеки, при Словацькому аграрному університеті в Нітрі. Встановили, кількість принесеного обніжжя за добу однією сім'єю: з 27.04 по 03.05.16 р. – 50,8 ± 2,25 г; з 04.05 по 06.05.16 р. – 100,0 ± 3,33 г; з 07.05 по 17.05.16 р. – 270,7 ± 11,79 г; з 18.05 по 22.05.16 р. – 100,5 ± 3,028 г; з 23.05 – 25.05.16 р. – 39,8 ± 2,74 г. Визначили морфологічні параметри пилкової грудочки обніжжя з Brassica napus L.: довжина у межах від 3,40 ± 0,061 мм

Citation:
Redina, N.M., Adamchuk, L.O., Nikolaieva, N.V., Brindza, J. (2016). Morphological characteristics of bee pollen obtained from *Brassica napus* L. *Scientific Messenger LNUVMBT named after S.Z. Gzhytskyj*, 18, 2(68), 73–78.

до 3,66 ± 0,048 мм; ширина у межах від 2,88 ± 0,059 мм до 3,26 ± 0,067 мм; маса у межах від 8,65 ± 0,317 мг до 11,31 ± 0,241 мг; сформованість у межах від 4,62 – 4,96 балів. Ступінь монофлорності становив від 79,94 ± 0,619% до 98,00 ± 0,202%. Отримані результати підтверджують, що активність льоту бджіл на зборі білкового корму з B. napus залежить від періоду його цвітіння та інтенсивності виділення нектару. Пилкові грудочки обніжжя з B. napus великі, щільні, правильної форми, без надколів, що вказує на можливість використовувати їх для виробництва у промислових обсягах.

Ключові слова: *бджолине обніжжя, пилкова грудочка, монофлорність, сформованість, Brassica napus L., морфологічні параметри.*

Морфологическая характеристика пчелиной обножки полученной из *Brassica napus* L.

Н.М. Редина, Л.А. Адамчук, Н.В. Николаева, Я. Бриндза
redina234@ukr.net, leonora.adamchuk@gmail.com, n.nikolaeva703@gmail.com, brindza.jan@gmail.com

Национальный университет биоресурсов и природопользования Украины,
ул. Героев Обороны, 11, Киев, 03041, Украина;
Словацкий аграрный университет в Нитре, Нитра, Словакия

Целью работы было исследование морфологической характеристики монофлорной пчелиной обножки полученной из Brassica napus L. Поставленные задачи: установить период получения пчелиной обножки; осуществить отбор пчелиной обножки течение цветения вида; установить монофлорность общего сбора обножки; исследовать морфометрические показатели обножки по параметрам пыльцевого комочка, сформированности и массы. Отбор обножки осуществляли в Сквирском районе Киевской области от семей Apis mellifera L. местной популяции. Морфометрические измерения проводили в Институте сохранения агробиоразнообразия и биологической безопасности, при Словацком аграрном университете в Нитре. Установили, количество принесенной обножки в сутки одной семьей: с 27.04 по 03.05.16 г. – 50,8 ± 2,25 г.; с 04.05 по 06.05.16 г. – 100,0 ± 3,33 г.; с 07.05 по 17.05.16 г. – 270,7 ± 11,79 г.; с 18.05 по 22.05.16 г. – 100,5 ± 3,028 г.; с 23.05 по 25.05.16 г. – 39,8 ± 2,74 г. Определили морфологические параметры пыльцевого комочка обножки с Brassica napus L.: длина в пределах от 3,40 ± 0,061 мм до 3,66 ± 0,048 мм; ширина в пределах от 2,88 ± 0,059 мм до 3,26 ± 0,067 мм; масса в пределах от 8,65 ± 0,317 мг до 11,31 ± 0,241 мг; сформированность в пределах от 4,62 – 4,96 баллов. Степень монофлорности составлял от 79,94 ± 0,619 % до 98,00 ± 0,202 %. Полученные результаты подтверждают, что активность лета пчел на сборе белкового корма из B. napus зависит от периода его цветения и интенсивности выделения нектара. Пыльцевые комочки обножки с B. napus крупные, плотные, правильной формы, без надколов, что указывает на возможность использовать их для производства в промышленных объемах.

Ключевые слова: *пчелиная обножка, пыльцевые комочки, монофлорность, сформированность, Brassica napus L., морфологические параметры.*

Introduction

In recent years Ukraine has increased the plantings of *B. napus*. According to the records of State Statistics Service of Ukraine the rapeseed area are: in 2015 – 874,000 ha, in 2014 – 865,000 ha, in 2013 – 988,000 ha (Maslak, 2015). It provides a widespread feed base for bees. The share of winter rape is about 95% (Maslak, 2015), which provides protein feed for bees in late spring and contribute to development of bees' families for main honey collection. Besides, *B. napus* in such volumes is a source of a considerable number of monofloral marketable honey, bee pollen and bee bread. As any type of monofloral beekeeping product, B. *napus* bee pollen has relatively stable biochemical composition and therefore constant properties and effect on human body that still poorly understood.

The production technology of monofloral bee pollen types needs to improve, especially its evaluation on a number of indicators. Among them the morphometric parameters aren't well–studied. It gives an idea about identifying indicators, shaping level, total mass of bee pollen collection and opportunity to plan the volume of product manufacturing in certain conditions (areas, duration of flowering, the number of bee families). Formation of scientific knowledges in that direction can contributes the improvement of technological solutions of bee pollen traps construction, bees training measures on a particular plant species, establishing the classification criteria of *B. napus* monofloral bee pollen and deepening scientific view on bee pollen morphology in general. The above items determine relevance of themes of studies.

Demand on bee pollen is growing. That motivates scientists to keep studying its biological characteristics and nutrients. In Brazil, a group of scientists (Almeida–Muradiana et al., 2005) has investigated 10 types of polyfloral bee pollen, and has determined the content: ash, lipids, proteins, carotenoids, vitamin C. Also they determined that most of the pollen in the bee pollen composition had belonged to *Arecaceae* and *Myrtaceae* families. But, they couldn't identify the botanical origin of each type of bee pollen. A lot of research work is being conducted towards of scientific investigates on ways of pesticides moves in bee pollen as a result of pesticide treatment for plant protection and technogenic pollution (Furman and Lisohurska, 2007; Smodiš Škerl et al., 2009; Brovarskyi et al., 2009).

Biological features of harvesting protein bee feed were defined (Brovarskij and Brindza, 2010) and it has depended from family state, natural and climatic conditions, technologies which are constantly improving on the bee pollen and bee bread obtaining. The biochemical and morphological characteristics of pollen of some species of

plants were analyzed (Bernard and Bradleigh, 1994; Brindza and Brovarskyi, 2013; Grygorieva et al., 2015).

Quality attributes of bee pollen were defined (Adamchuk, 2013; *Brindza* et al., *2015*) in conditions of Ukraine. Nevertheless on a significant amount of researches, morphological characteristics of bee pollen and identification of botanical species of this production require further studies by using modern scientific and technical methods.

The *purpose* of this work was to research the morphological characteristics of monofloral bee pollen obtained from *B. napus*. For achieving this purpose were determined the following tasks: to define the receiving period of bee pollen from *B. napus*; to collect the bee pollen during flowering phase of *B. napus*; to find out the monoflorality ratio of total pollen collection; to explore the morphometric data pollen by parameters of pollen lumps, shaping level and weight.

Material and methods

At the first stage of researches pollen selection was carried out the in Skvyra district of Kyiv region by means of hinged bee pollen traps from 10 local populations of *Apis mellifera* L. bee colonies. Thus we fixed the selection calendar date, incoming daily weight and determined monoflorality ratio of total bee pollen collection by generally accepted methods (Adamchuk, 2013).

B. napus arrays had sown by one way continuous with string of aisle is 15 cm. To prevent receiving polyfloral pollen bee colonies were transported to the *B. napus* arrays at the beginning of blooming and trained on color and smell. The second stage was carried out morphometric measurements of bee pollen lumps in the laboratory Institute Biodiversity Conservation and Biosafety Slovak University of Agriculture in Nitra. The average samples of bee pollen with weight of 100 g have taken for analysis. Weight of individual pollen lumps were determined by using analytical scales ANG 100C (Axis).

Length and width of bee pollen were measured with software Ascension Waves Vision on photos of pollen lumps from electron microscope Zeiss SteREO Discovery V20. Bee pollen shaping level was determined by method, which was developed at the Department of beekeeping NULES of Ukraine (Adamchuk, 2013). Obtained numeric data were subjected to statistical analysis in the Microsoft Office Excel – 2010.

Results and discussion

We determined that period of bee pollen selection from *B. napus* in conditions of Skvyra district (Kyiv region) is lasted from 27th of April to 25th of May 2016. We conditionally divided the period of bee pollen collection on 5 phases, depending on the pollen productivity of bee colonies (tab. 1).

Analyzing the amount of brought pollen in different stages was found, that the highest pollen productivity of bee families was at the 3rd stage. So, from 7th to 17th of May, colonies brought in 81.2% more than in 1st stage and in 63.1%, 61.2% and 85.3% more – in 2nd, 4th and 5th stages respectively. Probably such result is due to the fact that in the first 10 days of flowering bees preferred to gathered nectar, whereas at the end of flowering bees reduced flight activity and in general concentrated on other honey plants.

Monoflorality ratio of total pollen collection was determined for each stage. For this were selected samples (50 g) and conducted the appropriate calculations (tab. 2).

Table 1

Pollen–collecting activity of bees on *Brassica napus* L. (n = 10)

Stage of selection	Number of days in stage	Calendar date of selection	Collecting pollen for 1 day by 1 colony, g (M±m)	The visual characteristic
1	7	27.04 – 03.05.16 p.	50.8 ± 2.25	Bright yellow color, matt; large clumps, dense, regular shape without splits
2	3	04.05 – 06.05.16 p.	100.0 ± 3.33	
3	11	07.05 – 17.05.16 p.	270.7 ± 11.79	
4	5	18.05 – 22.05.16 p.	100.5 ± 3.028	
5	3	23.05 – 25.05.16 p.	39.8 ± 2.74	

Table 2

***Brassica napus* L. monoflorality ratio of total bee pollen collection and shaping level (n = 50)**

Indicator	Stage of selection				
	1	2	3	4	5
monoflorality, %					
Min	80.00	85.00	96.00	92.00	75.00
Max	90.00	95.00	100.00	100.00	85.00
M±m	84.70 ± 0.639	90.10 ± 0.580	98.00 ± 0.202	95.60 ± 0.491	79.94 ± 0.619
δ	3.50	3.18	1.11	2.69	3.39
C_v	4.13	3.53	10.79	2.80	4.24
shaping level, point					
Min	4.00	4.00	4.00	4.00	4.00
Max	5.00	5.00	5.00	5.00	5.00
M±m	4.62 ± 0.090	4.64 ± 0.089	4.96 ± 0.036	4.88 ± 0.060	4.88 ± 0.060
δ	0.49	0.48	0.20	0.33	0.33
C_v (%)	10.61	10.45	10.79	6.73	6.73

We determined that monofloral pollen was collected at all stages, pollen impurities from other plant species aren't dominated 25%. The highest monoflorality ratio of bee pollen was characterized in 3rd and 4th stages. So, from 7th to 17th of May, colonies brought in 13.6% more of monofloral pollen than in 1st stage and 8.1%, 2.1%, 18.4% more – in 2nd, 4th and 5th stages, respectively. Thus, it is clear that in 5th stage (the last 3 days of flowering) bees have begun to look new sources of feed. As a result pollen clumps from other plant species were got in bee pollen. Hence, to prevent falling polyfloral pollen to the total bee pollen collection, pollen lattice had to be turned off at three days before the end of *B. napus* flowering.

There were determined that bee pollen of *B. napus* conforms to 4–5 points on a scale formation. It confirms a high resistance to mechanical damage of pollen lumps, splits and can be produce in commercial scale. Thus, bee pollen shaping levels were averaged in the range from 4.62 ± 0.090 to 4.96 ± 0.036 points. The coefficient of variation for these two signs was weak.

For bee pollen were determined morphological parameters and weight (tab. 3). All measurements were determined by using special software on photos from electron microscope (Fig.).

Table 3

***Brassica napus* L. bee pollen morphological parameters and weight (n = 50)**

Indicator	Stage selection				
	1	2	3	4	5
length, mm					
Min	2.65	2.88	3.18	2.81	2.65
Max	4.08	4.83	4.24	4.21	4.08
M ± m	3.40 ± 0.061	3.52 ± 0.069	3.66 ± 0.048	3.54 ± 0.068	3.41 ± 0.060
σ	0.33	0.38	0.27	0.37	0.33
C_v (%)	9.75	10.79	7.24	10.45	9.75
width, mm					
Min	2.34	2.13	2.57	2.24	2.34
Max	3.47	3.93	4.03	3.83	3.47
M ± m	2.88 ± 0.059	2.96 ± 0.070	3.26 ± 0.067	3.02 ± 0.077	2.88 ± 0.050
σ	0.32	0.39	0.37	0.42	0.32
C_v (%)	11.25	13.03	11.25	14.06	11.23
weight, mg					
Min	3.80	2.10	8.50	5.80	3.80
Max	14.20	15.40	15.00	16.90	14.20
M±m	8.65 ± 0.317	8.58 ± 0.444	11.31 ± 0.241	9.86 ± 0.357	8.65 ± 0.317
σ	2.24	3.14	1.70	2.52	2.24
C_v (%)	25.92	36.57	15.04	25.58	25.92

We revealed that length of pollen clumps is the most stable indicator among morphological parameters. Its variation was in the range from 7.24% to 10.79%. We found out that bee pollen with the highest shaping level (collection of the 3d stage) had the largest parameters of length, width and weight.

Thus, the length of pollen lumps was 3.66 ± 0.048 mm in the period from 7th to 17th of May that in 7.1%, 3.8, 3.3, 6.8% more than in the 1st, 2nd, 4th and 5th stages, respectively. Width of pollen lumps collected on the 3rd stage was 3.26 ± 0.067 mm that in 11.7%, 9.2, 7.4, 11.7% more than in 1st, 2nd, 4th and 5th stages, respectively.

Weight of brought bee pollen was in the range from 8.65 ± 0.317 mg to 11.31 ± 0.241 mg. Thus, the smallest weight of bee pollen we had in 1st and 2nd stages. Minimum weight values of bee pollen were observed in the first 10 days of *B. napus* flowering and it was 2.10 mg and 3.80 mg on the 2nd and 1st stage of collection. It confirms that bees flying are concentrated on carbohydrates feed preparing.

Results confirm that the activity of bees flying, during collection of protein feed within one botanical species, depends on blooming period and nectar secretion. Thus, in the first 10 and the last 3 days *B. napus* flowering bees brought smaller bee pollen by weight and morphological parameters, which are characterized by a lower shaping level that compared to mid flowering array. In addition in the last three days the amount of pollen lumps from other plant species significantly increased those reductions on monoflorality ratio of total pollen collection.

Conclusions

Scientific knowledge was deepened about morphology of *B. napus* bee pollen with such parameters: length (3.40 – 3.66 mm), width (2.88 – 3.26 mm), weight (8.65 – 11.31 mg) and shaping level of pollen clumps (4.62 – 4.96 points), monoflorality ratio of total pollen collection (79.94 – 98.00 %).

Bee pollen clumps of *B. napus* are large, dense, with regular shape, without splits, these indicate on the possibility of their use for commercial scale. First time of the most appropriate period of flowering species was determined for the quality production of *B. napus* monofloral pollen in the Kiev region.

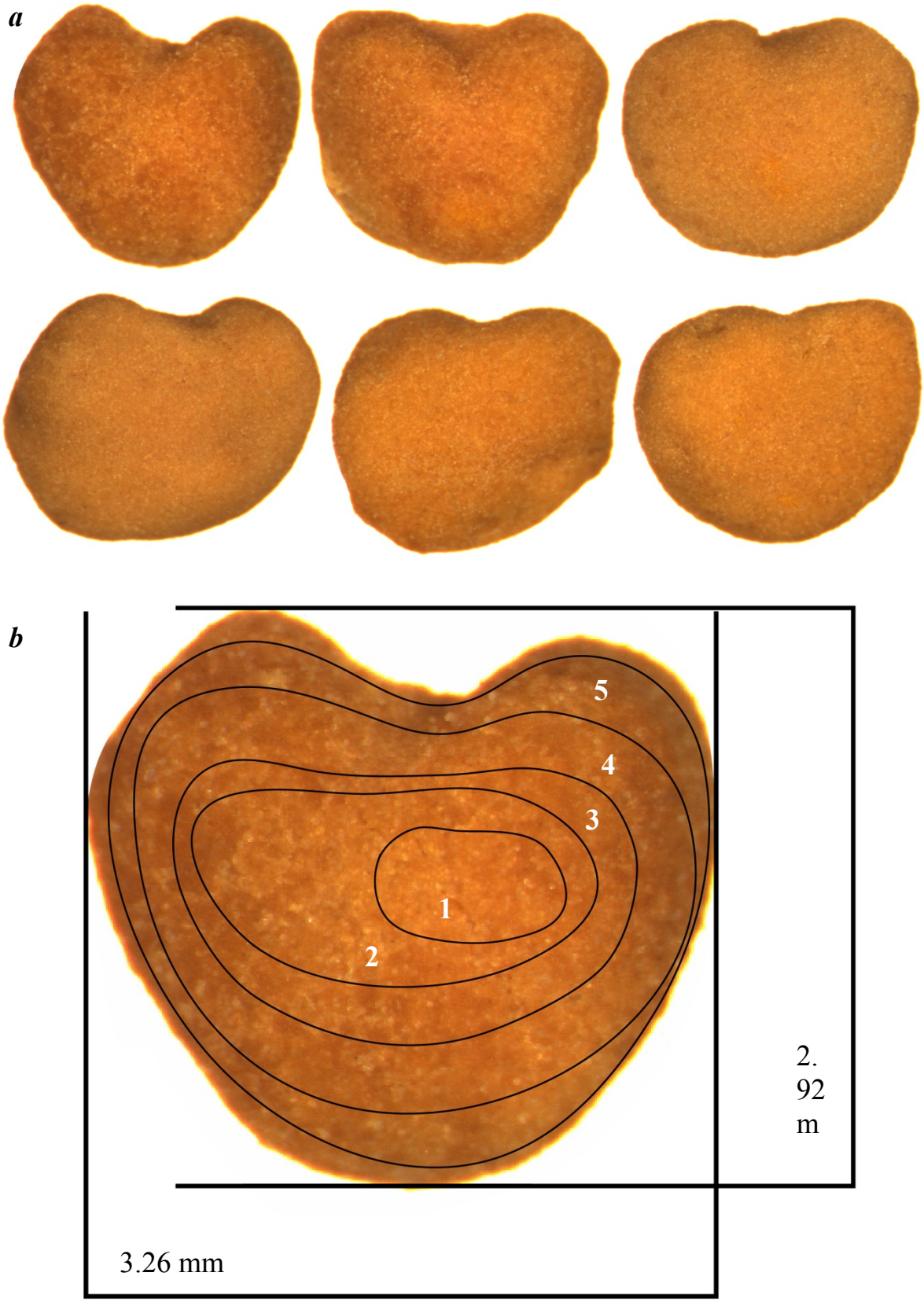

Figure. Morphological characteristics of *Brassica napus* L. bee pollen
(*a – variety of pollen lumps; b – measurement of pollen lump; 1–5 – shaping levels*)

Prospects for further research. The subsequent researches in this direction may be relevant to clarify of biochemical composition of *B. napus* monofloral pollen, spectrometry, to improve the methods of botanical identification, to development the technological solutions for increasing production volumes of monofloral bee pollen and bee bread from *B. napus* pollen.

Acknowledgement. Co–author L. Adamchuk thanks to the International Visegrad Fund for scholarship and research internships, during which were got the results and knowledge presented in this paper.

References

Adamchuk, L.O. (2013). Klasyfikatsiini oznaky bdzholynoho obnizhzhia [Classifications bee pollen]. Тваринництво України [Animal husbandry Ukraine], 5, 16–21. Doi: TvUkr_2013_5_7.pdf. (in Ukrainian)

Adamchuk, L.O. (2013). Sformyrovannost – pokazatel kachestva obnozhky [Shaping level an indicator of the quality of bee pollen]. Pchelovodstvo [Beekeeping], 6, 56–57 (in Russian)

Almeida–Muradiana, L.B., Pamplonaa, L.C., Coimbraa, S., Barthb, O.M. (2005). Chemical composition and botanical evaluation of dried bee pollen pellets. Journal of Food Composition and Analysis, 18, 1, 105–111.

Bernard, E.V., Bradleigh, V. (1994). Pollen morphology and its effect on pollen collection by honey bees, Apis Mellifera L. (Hymenoptera: Apidae), with special reference to upland cotton, Gossypium hirsutum L. (Malvaceae). Journal Grana, 33, 128–138.

Brindza, J., Schubertova, Z., Brovarskyi, V., Motyleva, S., Mertvischeva, M., Grygorieva, O. (2015). Morphological characteristics of common buckwheat (Fagopyrum esculentum Moench) pollen grains and bee pollen. Naukovyi visnyk NUBiP Ukrainy. Seriia: Tekhnolohiia vyrobnytstva i pererobky produktsii tvarynnytstva [Scientific journal nules Ukraine. series: technology of production and processing of animal products], 223, 17–24. ISSN 2222–8578.

Brindza, J., Brovarskyi, V. (2013). Pollen and bee pollen of some plant species. Kiev: Korsunskiy vidavnichiy dim «Vsesvit». ISBN 978–80–552–1073–5.

Brovarskij, V., Brindza, J. (2010). Včelí obnôžkový peľ [Bee pollen]. Kyjev–Nitra: FOP I. S. Maidachenko. ISBN 978–966–8302–31–2 (in Slovak)

Brovarskyi, V.D., Holovetskyi, I.I., Losiev, O.M., Adamchuk, L.O. (2009). Bdzholyne obnizhzhia, vyrobnytstvo ta zberihannia [Bee pollen production and keeping]. Kyiv: FOP I. S. Madanchenko (in Ukrainian)

Furman, S.V., Lisohurska, D.V. (2007). Koefitsiienty perekhodu 137Cs v systemi grunt – roslyny – produkty bdzhilnytstva [137Cs transfer factor in the system: soil – plants – bee products]. Tvarynnytstvo Ukrainy [Animal Ukraine], 11, 39–40 (in Ukrainian)

Grygorieva, O., Nikolaieva, N., Brindza, J., Klymenko, S. (2015) Pollen and bee pollen features of Sweet Chestnut (Castanea sativa Mill.). Naukovyi visnyk NUBiP Ukrainy. Seriia: Tekhnolohiia vyrobnytstva i pererobky produktsii tvarynnytstva [Scientific journal nules ukraine. Series: technology of production and processing of animal products], 223, 35–40. ISSN 2222–8578 (in English).

Maslak, O. (2015) Pryvablyvist ripaku [The attractiveness of rape]: Ahrobiznes sohodni, 13 (308). Doi: http://www.agro–business.com.ua/ekonomichnyi–gektar/3337–pryvablyvist–ripaku.html. (in Ukrainian)

Smodiš Škerl, M.I., Bolta, Š.V., Baša Česnik, H., Gregorc, A. (2009) Residues of pesticides in honeybee (Apis mellifera carnica) bee bread and in pollen loads from treated apple orchards. Bulletin of Environmental Contamination and Toxicology, 83, 3, 374–377. (in English).

Стаття надійшла до редакції 5.09.2016