




OPEN ACCESS

# Mapping the teaching of honeybee veterinary medicine in the European Union and European Free Trade Area

Despoina Iatridou <sup>1,2</sup>, Laura Pohl,<sup>3</sup> Ivana Tlak Gajger,<sup>4</sup> Nancy De Briyne,<sup>1</sup> Ana Bravo,<sup>5</sup> Jimmy Saunders<sup>2</sup>

**To cite:** Iatridou D, Pohl L, Tlak Gajger I, *et al.* Mapping the teaching of honeybee veterinary medicine in the European Union and European Free Trade Area. *Veterinary Record Open* 2019;**6**:e000343. doi:10.1136/vetreco-2019-000343

AB and JS contributed equally.

Received 14 March 2019

Revised 10 July 2019

Accepted 18 September 2019



© British Veterinary Association 2019. Re-use permitted under CC BY-NC. No commercial re-use. Published by BMJ.

<sup>1</sup>Federation of Veterinarians of Europe, Brussels, Belgium

<sup>2</sup>Department of Medical Imaging of Domestic Animals and Orthopaedics of Small Animals, Ghent University Faculty of Veterinary Medicine, Merelbeke, Belgium

<sup>3</sup>European Association of Establishments for Veterinary Education (EAEVE), Vienna, Austria

<sup>4</sup>Department for Biology and Pathology of Fish and Bees, Faculty of Veterinary Medicine University of Zagreb, Zagreb, Croatia

<sup>5</sup>Department of Anatomy, Animal Production and Veterinary Clinical Sciences, Veterinary Faculty University of Santiago de Compostela, Lugo, Spain

## Correspondence to

Dr Despoina Iatridou; [despoina@fve.org](mailto:despoina@fve.org)

## ABSTRACT

**Background** Honey bee (*Apis mellifera*) is a very important species for human beings, animals, environmental biodiversity, crop production and economic sustainability in Europe and worldwide. This study investigates whether future veterinarians are trained to deal with the particular needs of the only traditional food-producing insect in Europe.

**Methods** This study analyses data collected from 77 European veterinary education establishments in EU and the European Free Trade Area.

**Results** The results show that 75 per cent of those establishments (58 out of 77) teach honeybee veterinary medicine. There is a clear geographical differentiation. In north-western countries only about half of the establishments include honeybee health, production and product inspection in their undergraduate curricula, while in eastern, central and southern countries, which are also important beekeeping countries, the great majority of the establishments incorporate honeybee veterinary medicine in their undergraduate curriculum. Eighty-six per cent of all the establishments teaching honeybee veterinary medicine (50 of the 58) incorporate it in their core curriculum either as separate subject or as part of other subjects. Twenty-five per cent of all the establishments (19 out of 77) organise postgraduate training courses in this field.

**Conclusions** Veterinarians have an important role in ensuring the health, sustainability and productivity of managed honeybee colonies as they do for other animal species. It seems however that teaching of honeybee veterinary medicine receives less attention in undergraduate veterinary curricula in EU compared with other fields of veterinary medicine. Seeing the increasing importance of honey bees for crop protection, environmental protection and economic sustainability, it would be beneficial to further strengthen the education of honeybee veterinary medicine in the future. Establishments should encourage and prepare veterinarians for practising science-based veterinary medicine in honey bees by incorporating such teaching in undergraduate curricula and by providing postgraduate opportunities to qualified veterinarians wishing to enhance their basic skills in this field.

## INTRODUCTION

Honey bee (*Apis mellifera*) is an ecologically and economically very important species contributing directly to human nutrition and

health as well as to global economic sustainability. The different honeybee products, namely honey, propolis, pollen, beeswax, venom and royal jelly, serve both as valuable nutritional sources for human beings as well as essential raw materials for many industrial sectors, such as food and beverages, agriculture, medicines, cosmetics, paints, chemicals and more.<sup>1,2</sup> Honeybee colonies are further essential for agriculture and environment, ensuring plant reproduction and biodiversity by pollination, while beekeeping is an important sector that contributes to the development of rural areas.<sup>3,4</sup>

European apiculture is one of the most dynamic agricultural sectors in the EU. Beekeeping is practised in all EU countries. Southern and central-east countries, where climatic conditions are more favourable, are the major beekeeping countries in EU and European Free Trade Area (EFTA). Even though EU is the world's second most important honey producer after China, domestic production only covers around 60 per cent of consumption. Therefore, EU is at the same time an important importer of honey from third countries, such as China, Ukraine and countries of Latin America.<sup>5-7</sup>

Outlooks for apiculture in the future should have been very optimistic, if the sector had not had to face important challenges as a consequence of high bee mortality due to a number of detrimental factors. Extended use of pesticides, biological factors or climate change are considered as potential causes of the colony losses.<sup>8,9</sup> This has been well acknowledged by EU policy makers,<sup>10-13</sup> who have called for a number of supporting initiatives during the last decade, including the education of veterinarians, for the protection of managed honeybee colonies and wild bee populations and of the European apiculture in the Union.

Veterinarians have an important role to play in ensuring the health, sustainability and productivity of managed honeybee colonies as they do for other animal species. Implementing good veterinary, beekeeping and environmental practices can guarantee the safety of apiculture food products as well as environmental biodiversity.<sup>14</sup>

The aims of this research were to gain a better understanding of the undergraduate veterinary curricula offered in the EU and Free Trade Area,<sup>15</sup> and to investigate whether future veterinarians are trained to deal with the particular needs of this sector.

Veterinary curricula in Europe constantly adapt to follow the developments in science, to comply with the applicable legislation, and to meet the societal demands and the needs of the job market. This applies to the whole range of diversity of the veterinary medicine, including the teaching of bee health and production. The present investigation looked into whether this subject is part of the curricula in the European veterinary education establishments (VEEs); whether it is part of the core curriculum or it is offered to undergraduates as elective; how much of the teaching workload is dedicated to this topic; and so on. In addition, the authors analysed information on postgraduate courses and programmes offered in this species by the VEEs.

## MATERIALS AND METHODS

The European Association of Establishments for Veterinary Education (EAEVE),<sup>16</sup> in collaboration with the Federation of Veterinarians of Europe (FVE),<sup>17</sup> developed and launched a quantitative online survey to collect data in less popular areas of the veterinary medicine taught in European VEEs. The survey specifically looked into the teaching of laboratory animal medicine,<sup>18</sup> aquatic animal medicine<sup>19</sup> and honeybee medicine, as part of the veterinary curricula in the different European VEEs. In this report, the authors only present the findings of the survey related to bee health.

The survey was addressed to the deans of all 96 European VEEs in 34 countries which are members of the EAEVE.<sup>16</sup> It was launched at the end of 2013 through SurveyMonkey. A total of 88 VEEs completed and returned the survey by the beginning of 2014. The results of the survey were crosschecked one by one with the VEEs at the end of 2016.

For the analysis the authors focused only on the VEEs located in EU and the EFTA, as this region is subject to a common legislative framework. Seventy-seven VEEs are in total established in a country of this region. Of the 77 VEEs, data were collected from 66 of them through the survey. Quantitative data collection was supplemented by secondary data from the self-evaluation reports<sup>20</sup> of the 11 VEEs that had not returned the survey. These self-evaluation reports were prepared by the VEEs for their evaluation by the European System of Evaluation of Veterinary Training (ESEVT),<sup>21</sup> and are publicly available documents containing information on the curriculum,

continuing education and postgraduate education offered by the VEE to be evaluated.

ESEVT has been developed by EAEVE in collaboration with the FVE,<sup>17</sup> and run for over 33 years. In 2018, ESEVT was successfully accredited by the European Association for Quality Assurance in Higher Education (ENQA),<sup>22</sup> getting international recognition. Sixty-eight of the 77 VEEs considered in this analysis were evaluated by ESEVT and hold the status of 'Accredited'/'Approved' (decision of May 2017).<sup>23</sup>

Data were quantitatively analysed using Microsoft Excel, and descriptive research was performed for the comparative analysis of certain results, such as subjects and time of teaching.<sup>24</sup>

The results of the analysis of overall data from these 77 VEEs are shown in the Results section.

## RESULTS

### Level and type of training in honeybee veterinary medicine in undergraduate veterinary curricula in the EU and EFTA

Fifty-eight of the 77 VEEs include teaching of honeybee veterinary medicine in their curriculum. It can be obligatory (hours in the core curriculum that all students need to complete), elective (courses offered to students as an option), or partly obligatory and partly elective. Results show that 33 of the 58 VEEs include honeybee veterinary medicine in the core curriculum, 17 VEEs provide it partly obligatory-partly elective, and eight of them offer it as an option to follow if interested (elective) (figure 1).

Twenty-five of those 58 VEEs have a separate subject and 33 VEEs incorporate it as part of other subjects.

When honeybee veterinary medicine is part of other subjects in the curricula, it is included in subjects such as the following:

- ▶ Microbiology/parasitology/infectious and parasitic diseases.
- ▶ Zootechnics/animal production systems.
- ▶ Toxicology.
- ▶ Propaedeutics/clinical diseases.
- ▶ Diseases of miscellaneous animals.
- ▶ Food technology/food hygiene.

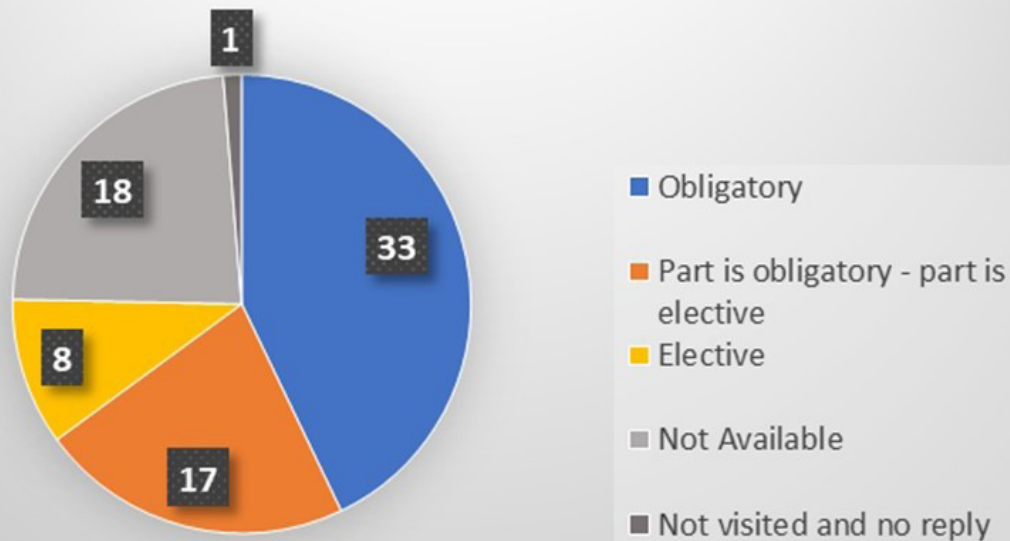
As a separate subject, bee health and apiculture are referred as the following:

- ▶ Apiculture and diseases of bees.
- ▶ Biology and pathology of beneficial insects/bees and silkworms.
- ▶ Disease of fish and bees.
- ▶ Zoology and biological or chemical threats on swarms.

There is rather a variation with regard to the time of the veterinary studies that honeybee veterinary medicine is taught throughout the European veterinary curricula, with the main part of it taught in the middle of the studies, that is, third to fourth year of the curriculum.

Focusing on the 68 VEEs that hold the status of 'Accredited'/'Approved' by the ESEVT,<sup>21</sup> 24 offer training on bee health as a separate subject, 29 as part of other subjects

## Obligatory vs. elective training in Honeybee Veterinary Medicine in the curriculum of veterinary schools in the EU and European Free Trade Area



**Figure 1** Obligatory versus elective training in honeybee veterinary medicine in the curriculum of veterinary education establishments (*absolute numbers*) in the EU and European Free Trade Area.

and 15 do not include such training in their curriculum (figure 2).

In terms of geographical distribution, the authors observe that honeybee veterinary medicine is part of the veterinary curricula in at least one VEE in each country of southern, central and eastern Europe, while there are four countries in north-western Europe where none of their VEEs includes teaching of honeybee veterinary medicine in their curricula (figure 3).

### Hours of training dedicated to teaching honeybee veterinary medicine in VEEs in the EU and EFTA

Data from 48 VEEs that replied to this question show that 22 of them provide up to 10 hours of teaching of honeybee veterinary medicine to all students, while 23 of them dedicate between 12 and 35 hours for the same subject in their core curricula (table 1).

Twenty-five of the VEEs which give the possibility to their interested students to follow elective courses in bee health and apiculture (17 of the VEEs provide electives on top of their obligatory training and eight exclusively as elective) dedicate on average between 25 and 56 hours. Table 2 gives an overview of the replies that were received.

### Postgraduate training in honeybee veterinary medicine for veterinarians

Data from 67 out of the 77 VEEs show that 19 of them (24.7 per cent) organise postgraduate training courses

on honeybee veterinary medicine (48 replied 'no', 1 replied 'occasionally' and 18 replied 'yes').

The level of postgraduate education varies from short courses for continuous professional development (CPD) of veterinary practitioners, PhD programmes and up to specialisation national programmes.

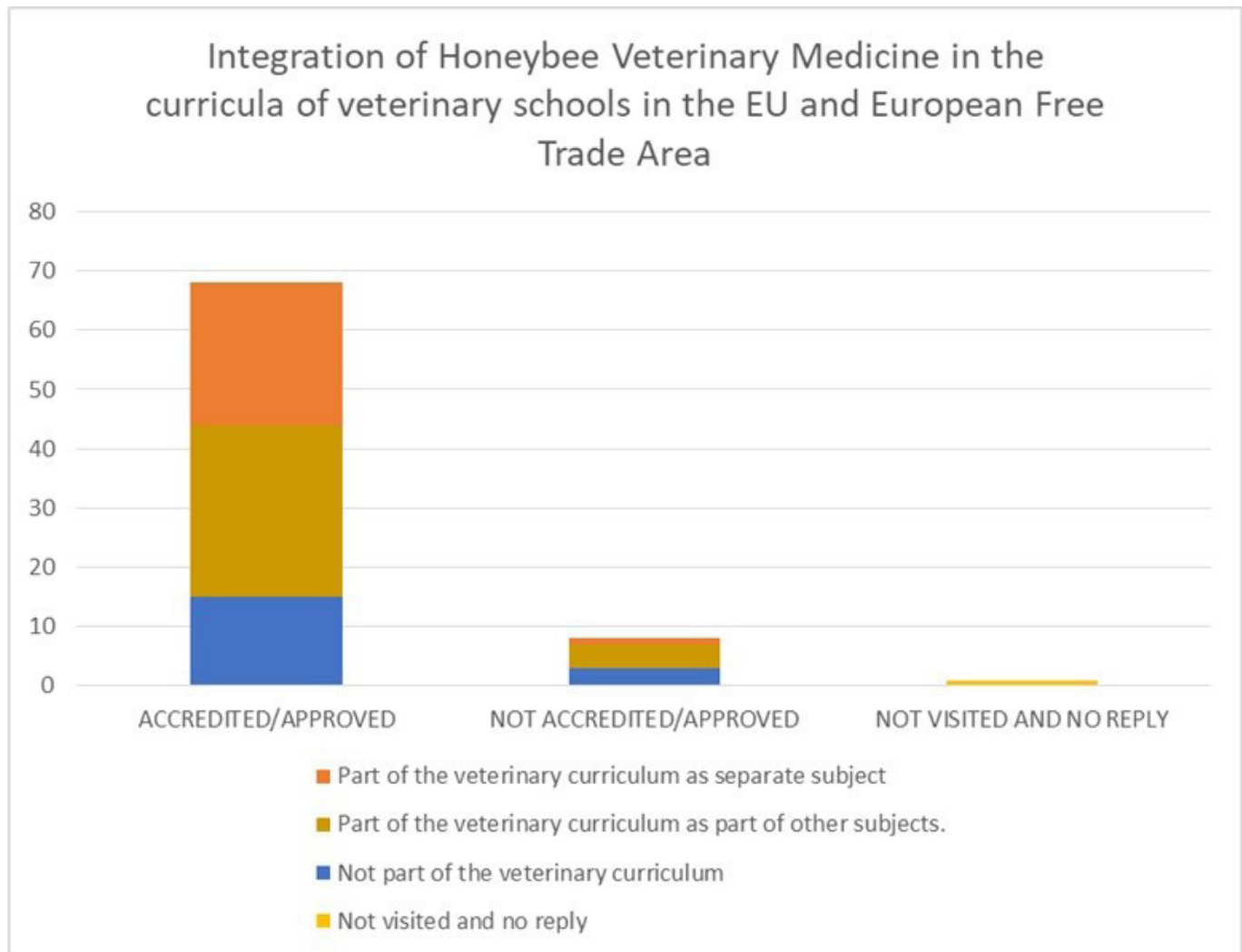
Further analysis of the overall results shows that 18 out of 58 VEEs that provide undergraduate training in honeybee veterinary medicine also provide postgraduate opportunities for veterinarians in this field. Ten out of the 18 VEEs that do not provide such training in the undergraduate curriculum also replied to this question; however, only one of them includes training in bee health and production as part of two master programmes.

The 19 VEEs that provide this kind of postgraduate training are based in 13 countries of the EU and EFTA in the central-south region of Europe (figure 3).

## DISCUSSION

### Veterinary education in EU and EFTA

Under the Treaty of Lisbon,<sup>25</sup> education is a policy area where the Union supports, complements or supplements the actions of the Member States (Article 6, Treaty on the Functioning of the European Union (TFEU)), but does not foresee harmonisation of national laws and regulations in this area (Articles 165 and 166, TFEU). Even though education is the cornerstone for creating qualified



**Figure 2** Integration of honeybee veterinary medicine in the curricula of veterinary education establishments (*absolute numbers*) in the EU and European Free Trade Area.

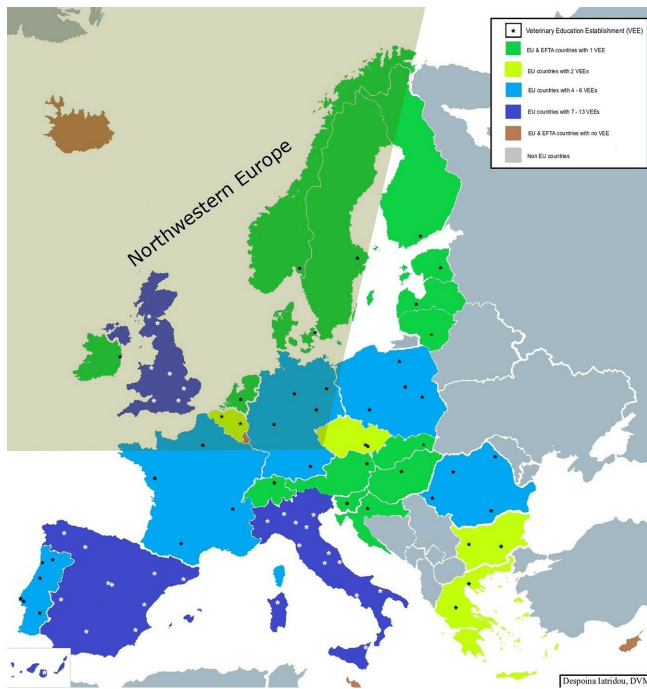
professionals in any field, it still falls under the subsidiarity principle.<sup>26 27</sup> Each Member State assumes full responsibility for the organisation of its education and vocational training systems and the content of its teaching.

Only for certain professions, the so-called ‘regulated professions’, the EU has set minimum requirements in Directive 2005/36/EC,<sup>28</sup> partially amended by Directive 2013/55/EU.<sup>29</sup> For veterinary surgeons, the list of competences is included in Annex V of the European Legislation and a minimum of 5 years of training is obligatory.<sup>28</sup> The listing of competences in Article 38 and subjects in Annex V intend to ensure that the veterinarians will be qualified at their graduation and ready to perform the responsibilities required by the EU law. Over the years, more references to the particular competences of the veterinarians and their responsibilities have been included in different pieces of EU legislation, such as the Animal Health Law,<sup>30</sup> the regulation on veterinary medicinal products,<sup>31</sup> the official controls<sup>32</sup> and others, which have been considered by the academia and the veterinary profession for developing the list of Day One Competences.<sup>33</sup> Prevention and

biosecurity; examination; early detection of diseases by carrying out proper diagnosis and differential diagnosis to rule out or confirm a disease; prescription and implementation of the right treatment; and raising awareness of resistance to treatments, including antimicrobial resistance, food inspection and so on are core competences<sup>33</sup> that graduate veterinarians should have acquired during their studies and be able to implement in the different domestic species, including managed honey bees.

### Training in honeybee veterinary medicine in EU and EFTA curricula

This survey takes a closer look into veterinary undergraduate training and presents how the EU VEEs prepare their graduates for roles within the apiculture sector as well as for public health inspection of honeybee products. The results of this survey show 58 out of the 77 VEEs (75 per cent) incorporate such teaching in their curriculum. The great majority of them (50 out of 58) have it incorporated in their core curriculum either as a separate subject (20 of 50 VEEs) or as part of other subjects (30 of 50 VEEs).



**Figure 3** Geographical distribution of veterinary education establishments in EU and European Free Trade Area (EFTA).

Eight VEEs replied that they have honeybee health and production exclusively as elective, five as separate subject and three as part of other subjects.

In the EU and EFTA, Regulation (EU) 2016/429 on transmissible animal diseases, the so-called Animal Health Law of the EU,<sup>30</sup> includes bees and honey in its scope and quotes Council Directive 92/65/EEC,<sup>34</sup> laying down animal health requirements governing trade in and imports into the community of those particular species. Veterinarians have a key role in ensuring the proper inspection before trade in line with the EU regulations and international standards, such as the World Organisation for Animal Health (OIE) Terrestrial Animal Health Code (the Terrestrial Code)<sup>1</sup> and the Sanitary and Phytosanitary Agreement of the World Trade Organization.<sup>35</sup>

It should be acknowledged that all VEEs in EU and EFTA require their graduates to gain a basic understanding of the anatomy, physiology, pathology

**Table 1** Hours allocated to honeybee veterinary medicine in core undergraduate curricula of veterinary education establishments (VEEs) in the EU and European Free Trade Area

Obligatory hours	VEEs
1–5 hours	10
6–10 hours	13
11–25 hours	15
26–40 hours	9
106 hours	1
Total	48

**Table 2** Time of training in honeybee veterinary medicine offered as elective in veterinary curricula in the EU and European Free Trade Area

Elective hours	Veterinary education establishments
3–10	3
11–25 hours	4
26–56 hours	16
120	2
Total	25

and treatment of all domestic and food-producing animals,<sup>29 30 33</sup> independently of the purposes they are used for. This certainly refers to all main domestic and food-producing species and not exclusively to mammal species. Additionally, each veterinarian has to follow the professional Code of Conduct.<sup>36</sup> Whereas honey bees are not specifically mentioned in the current Veterinary Act,<sup>36</sup> this should not be interpreted that the Act does not apply to these beneficial food-producing insects. Practising veterinary medicine in honeybee colonies requires a qualified profession for carrying out a clinical examination of honeybee colonies, recognising disease signs on brood and adult bees, sampling properly hive materials when suspicion for some of serious diseases occurs, and preparing those samples along with the formal cover documentation for the delivery to an authorised diagnostic laboratory. As it happens with other species, the veterinarian must be able to make proper diagnosis, apply eradication measures, advise about disease control and prophylaxis, as well as prescribe the right medicine. These are core competences that a veterinarian must acquire in order to be qualified to practise.<sup>24 33</sup>

Veterinarians certainly have a role to play in European apiculture and therefore have to be prepared respectively. While most of the EU and EFTA VEEs (over 70 per cent) recognise this need and dedicate a considerable part of their very full core curriculum to the teaching of honeybee veterinary medicine (figure 1), more efforts are necessary in order to raise awareness about the importance of this species and their needs. The authors observe that teaching of honeybee veterinary medicine is currently having a good cover in most VEEs, but still receiving the less attention in undergraduate veterinary curricula in EU compared with other less popular fields of veterinary medicine, such as laboratory animal medicine (83 per cent of the VEEs provide teaching in this area)<sup>18</sup> and aquatic veterinary medicine (96 per cent of the VEEs provide teaching in this area).<sup>19</sup>

Further analysis of the results reveals that there is a lot of diversity in the way that honeybee veterinary medicine is taught, in terms of time dedicated to it and of its structure within the different curricula in EU and EFTA countries. Further research to investigate models for teaching of honeybee veterinary medicine in undergraduate and postgraduate levels should be considered in the future,


**Table 3** Geographical analysis of teaching of honeybee veterinary medicine in EU and EFTA

Region of Europe	VEEs that include honeybee veterinary medicine		VEEs that do not teach honeybee veterinary medicine	No data/not visited VEEs	Total
	In core curriculum	As elective			
North-west/north	7	2	10	0	19
North-east/central/south	43	6	8	1	58
Total	50	8	18	1	77

with a view to promote a more harmonised approach in teaching of veterinary medicine in Europe.

Ten out of 18 VEEs which do not include teaching of honeybee veterinary medicine in their curricula are based in north-western Europe. This means that only about half of the 19 VEEs in this part of Europe (figure 3) teach about apiculture, health of honeybee colonies and honey inspection, while in four countries of that region none of their VEEs includes honeybee veterinary medicine within their undergraduate curricula. In the rest of the EU and EFTA (southern, central, eastern Europe), 49 out of the total 57 VEEs (86 per cent) for which the authors have data include teaching of honeybee veterinary medicine in their curricula (one VEE has not provided data and there was no self-evaluation report to obtain supplementary data since the establishment was never visited for accreditation purposes) (table 3).

This geographical variation is expected if it is seen in relation to data on major beekeeping countries in EU and EFTA.<sup>5 6</sup>

It is clear that more attention may be paid by VEEs in teaching of this particular field of veterinary medicine.

### Importance of quality assurance of veterinary education

ESEVT is a Europe-wide, profession-specific evaluation system that ensures efficient preparation of the veterinary students for the labour market and the only one accredited by ENQA.<sup>22</sup> ESEVT contributes to the standardisation of veterinary teaching approaches to ensure the learning outcomes of veterinary students and minimise any discrepancies in Day One Competences of European veterinarians. That way it contributes to transparency and trust to veterinary services throughout Europe.<sup>37</sup>

ESEVT evaluates the teaching and learning in higher education according to the approved standard operating procedure<sup>38</sup> and the approved Day One Competences.<sup>33</sup> It is worth mentioning that assessment of students is one of the major requirements of ESEVT, which must be clearly demonstrated in order for a VEE to gain the status of 'Approval' or 'Accreditation'. Lack of a valid and reliable system in place for the assessment of clinical skills and Day One Competences<sup>33</sup> of its students in a VEE constitutes a major deficiency that may lead to non-accreditation of the given VEE. This is an important note considering that often assessment drives learning of students. Assessment by ESEVT of the implementation of honeybee veterinary medicine in the European curricula

can ensure the Day One Competences of the European veterinarians in this field.

This survey shows that 53 out of the 68 'Approved'/'Accredited' VEEs offer training on bee veterinary medicine—24 as a separate subject and 29 as part of other subjects (figure 2). The authors note that one establishment which was not providing such bee health training at the time of this survey commented that they were in the process of implementation of such a course in their core curriculum as a result of the recommendation made after their evaluation by ESEVT.

ESEVT should continue to assess and promote the teaching of aspects related to honeybee health and safety of apiary products intended for human consumption. In the case of VEEs that do not yet implement such training within their curriculum, they should be encouraged to do so.

### Veterinarians' added value for apiculture and public health

Apiaries need veterinarians like dairy, pig or fish farms do. Honey bee is an important food-producing species, and beekeepers need advice and guidance on how to keep their colonies healthy and productive, as well as on how to ensure healthy and quality food for consumers, without deleterious residues. The veterinarian can advise on biosecurity and national plans, perform the clinical and laboratory examination on honeybee colonies, prescribe the most appropriate authorised medicine when necessary and implement national programmes for varroosis control. It is worth highlighting that apiculture in Europe is another sector that suffers from a remarkable lack of appropriate veterinary medicines authorised for honey bees (the same is observed in other sectors such as equine farming,<sup>39</sup> or aquaculture).<sup>19 40</sup> In fact, miticides to control the *Varroa destructor* mite are the only approved medications in EU. In the case of a diagnosed disease for which no available authorised product exists in the country, the veterinarian is the only professional empowered to select and prescribe under the cascade system the appropriate medicine for use in honey bees, most usually a product authorised for honey bees in another country.<sup>31</sup> The use of antibiotics in honey bees is practically not allowed in the EU.<sup>41</sup> Only if there is a justified need for their use in honey bees antibiotics can be used under the cascade.<sup>42</sup> However, this is not the case in other parts of the world,<sup>42–44</sup> where antibiotics are used mainly against American foulbrood, European foulbrood and noseosis. The veterinarian has a key role in selecting the right product for honeybee treatment, advising on its

responsible use and informing about withdrawal periods, residues and risks linked to the development of resistance.<sup>45</sup>

The veterinarian and veterinary services are also responsible for advising about transport and trade of honey bees and bumblebees in line with Union law<sup>34 46</sup> and international standards,<sup>1 35</sup> and for ensuring enforcement of legislation. Spreading of bee diseases, some of which are highly contagious for honey bees, is very easy due to different factors such as the nature of this species (wild and foraging species), climate conditions or insufficient border controls, perhaps as a result of the fact that the honey bee is not universally regarded as livestock, leading to less attention during their transport.<sup>47</sup>

Veterinarians also have to ensure public health. Unlike other animal species, zoonotic diseases coming from apiaries are rare. Public health risks for human beings related to beekeeping and its products come mainly from residues, bacteria, toxic substances and allergenic pollens found in honey and/or other apian products, or from allergic reactions due to accidental puncture from the bee sting. Bee is a species with a very different physiology from other domestic food-producing species, where the lack of hive metabolism does not allow the elimination of residues over a certain period of time.<sup>46</sup> Unsafe substances often found in honey are either environmental contaminants such as heavy metals (lead, cadmium and mercury), radioactive isotopes, organic pollutants, pesticides and pathogenic bacteria, or beekeeping contaminants such as acaricides, antibiotics and other chemicals.<sup>1 2</sup> These substances are serious threats to human health, while antibiotics used in beekeeping may additionally contribute to antimicrobial resistance. Practitioners and official veterinarians have a growing role in protecting the human health, in line with the EU legislation<sup>48–51</sup> and the OIE Terrestrial Code-Chapter 4.14.<sup>1</sup> Contamination of honey and other apian products with heavy metals, antibiotics and other agrochemicals could be considered a very good indicator of contamination of the environment with those substances. It is also a contamination indicator of overall food intended for human consumption. Bees can therefore be very important as biomarkers of environmental health within the One Health concept.<sup>52</sup>

Veterinarians, along with other stakeholders like agronomists and beekeepers, are responsible for supporting and helping to implement measures and activities aiming at protecting honey bees and ensuring public health<sup>53</sup> as well as ecosystem conservation. Pests, pathogens, pesticides and climate change are factors that affect honeybee ecosystems.<sup>54</sup> Honey bees are mainly food-producing species, but they are also important pollinators that ensure crop production, contributing to adequate food production for human beings and animals. The massive colony losses that have been observed in Europe<sup>55</sup> and worldwide<sup>56 57</sup> in recent years are in principle multifactorial One Health problems. Winter losses and dying of honeybee colonies during active beekeeping season or depopulation of adult workers<sup>58</sup> requires the One Health holistic approach<sup>52</sup> that considers human, animal and

environmental interactions and interprofessional collaboration in order to understand and identify the causing mechanisms and the underlying links and to intervene as appropriate. This is particularly important when considering that honey bee is the only domestic species whose feeding cannot be fully controlled and are very much affected by climate and environmental conditions.<sup>59</sup>

Veterinarians' contribution is fundamental to advising and educating beekeepers not only about management methods and biosecurity measures but about environmental conditions as well. Honeybee colonies are very sensitive to weather conditions, as they are affected directly by very low or high temperatures, precipitation, availability of water or wind, and consequently by climate change.<sup>60 61</sup> Honeybee colony survival depends on beekeepers' education,<sup>62</sup> who need to have a close collaboration with their veterinarian. As any other farmer, the beekeeper is responsible for keeping a healthy apiary, should comply with the respective legislative requirements, as well as ensure quality, safe and highly nutritious apian products.

All the above considerations confirm that teaching of honeybee veterinary medicine has to be part of the core veterinary curricula in Europe. All veterinary students must receive a minimum knowledge and training to acquire competences in honeybee health and production and should be encouraged to practise in this particular managed insect species. Honey bee, which has been traditionally the only food-producing insect in Europe, is at the same time very important for human and animal health and welfare, as well as a biomarker of environmental health. Honeybee colonies need and deserve veterinary care as well.<sup>14 59</sup>

### CPD in honeybee veterinary medicine

CPD is a professional responsibility for all veterinarians in the EU.<sup>29 36</sup> Recital 15 of Directive 2013/55/EC,<sup>29</sup> encourages and promotes lifelong learning for all regulated professions in the EU. Veterinarians shall maintain and enhance their knowledge and skills relating to the state of veterinary science and are responsible for being updated on the latest developments in veterinary science, developing their Day One qualifications, advancing professionally and preparing for more complex tasks and roles. The veterinary profession in Europe strongly promotes the principle of continuous education,<sup>63</sup> while ESEVT encourages all VEEs to develop postgraduate opportunities to cover the CPD needs of the veterinarians in their country.<sup>38</sup>

Results of this survey showed that only 28 per cent (19 out of 67) of the VEEs that provided data on postgraduate training organise CPD in the field of apiculture and honeybee colonies' health and production. Postgraduate programmes in honeybee veterinary medicine are available in 13 countries in EU and EFTA, the level of which varies from short courses to PhD programmes or national specialisation programmes.

Comparing those results with the existing postgraduate opportunities in other less popular areas of veterinary medicine, such as laboratory animal medicine and aquatic animal veterinary medicine, the authors observe that honeybee veterinary medicine has not been given the same attention. Only 19 VEEs organise postgraduate training in honey bees against 40 VEEs that do so in laboratory animal veterinary medicine and 30 VEEs in aquatic animals veterinary medicine.<sup>18 19</sup>

Additionally, specialisation in bee health and production is not that developed in Europe. Only a few national specialisation programmes exist, for example in France, Italy, Poland and Spain. Nevertheless, there is no veterinary college recognised by the European Board of Veterinary Specialisation (EBVS)<sup>64</sup> to provide European-wide recognition to veterinary specialists in honeybee veterinary medicine as it happens with other disciplines.<sup>65</sup> Academics and the veterinary profession should consider the current challenges and opportunities for veterinarians to be involved in apiculture and encourage the development of postgraduate opportunities in this field. Ideally some European organisation should consider developing the framework of minimum training requirements for such veterinary postgraduate programmes. The Veterinary Continuous Education in Europe,<sup>66</sup> for example, which is a joint initiative of EAEVE,<sup>16</sup> FVE,<sup>17</sup> EBVS<sup>64</sup> and the Union of European Veterinary Practitioners,<sup>67</sup> established with a view to encourage harmonisation and quality of postgraduate training programmes for practising veterinarians and to facilitate recognition of their competences throughout the EU, could consider to make such a proposal.

## CONCLUSIONS

Honey bee (*A mellifera*) is a very important species for human beings and animals, contributing directly to their nutrition and health, as well as to environmental biosecurity, crop production and economic sustainability in Europe and worldwide. Veterinarians have a vital role in ensuring honeybee health, productivity and profitability of apiaries, public health, and ecosystem conservation.

The results of our survey show that honeybee veterinary medicine is taught in most of the European VEEs (in 58 out of 77 VEEs), especially in eastern, central and southern countries of EU and EFTA, which are also important beekeeping countries. Considering the importance of this particular species and the need for well-educated veterinarians to deal with this, more attention should be paid by VEEs in honeybee veterinary medicine. ESEVT is the tool that can promote harmonisation of veterinary curricula in Europe and ensure proper implementation of teaching of honeybee veterinary medicine. This would enable graduate veterinarians to acquire the necessary competences and to be ready to practise veterinary medicine in apiaries, that is to say to handle, examine, diagnose and treat honeybee colonies, as well as to ensure the safety of their hive products. This way,

veterinarians will further contribute to ecosystem sustainability and the availability of safe and nutritive food for human beings in the future. Policy makers and industry should support apiculture sector, by supporting and encouraging beekeepers to seek veterinary advice and to establish a good collaboration with a veterinarian. VEEs in collaboration with the veterinary profession should consider the current challenges and opportunities for veterinarians to be involved in apiculture and encourage the development of postgraduate opportunities in this field as well.

**Acknowledgements** The authors express special thanks to all the veterinary education establishments - EAEVE members who replied to the questionnaire and provided data to this survey, and to the members of the European Coordinating Committee on Veterinary Training (ECCVT), who also supported the whole project. The authors also express special thanks to Professor László Fodor, former president of the EAEVE, who proposed and supported this project.

**Contributors** DI: conception and design, analysis and interpretation of data, drafting the article, final approval of the version to be published, and submission of the article. LP: acquisition of data, revising critically the article for important intellectual content and final approval of the version to be published. NDB: design, revising critically the article for important intellectual content and final approval of the version to be published. ITG: analysis and interpretation of data, revising it critically for important intellectual content, and final approval of the version to be published. AB: conception and design, acquisition of data, analysis and interpretation of data, revising critically the article for important intellectual content, and final approval of the version to be published. JS: conception, analysis and interpretation of data, revising critically the article for important intellectual content, and final approval of the version to be published.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** Veterinary Education Establishments have agreed to provide data to our survey under the condition that the presentation will be anonymous.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** All data relevant to the study are included in the article.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, an indication of whether changes were made, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

## ORCID iD

Despoina Iatridou <http://orcid.org/0000-0002-8648-2623>

## REFERENCES

1. World Organisation for Animal Health (OIE). General introductory text providing background information for the Chapters of the terrestrial animal health code on diseases of bees. Available: <http://www.oie.int/en/scientific-expertise/specific-information-and-recommendations/bee-diseases/> [Accessed 8 Mar 2019].
2. Industry ARC. Apiculture Market: By Products (Honey, Beeswax, Live Bees); By End-User Industry (Food & Beverages, Agriculture, Military, Medicine, Cosmetic, Paints and Chemical) and By Geography - Forecast (2018-2023). Available: <https://industryarc.com/Report/213/Global-Apiculture-Market-Forecast-Report.html/summary> [Accessed 8 Mar 2019].
3. Food and Agriculture Organisation of the United Nations. Republic of Slovenia Ministry of agriculture, forestry and food. The importance of bees and other pollinators for food and agriculture, 2018. Available: <http://www.fao.org/3/I9527EN/I9527en.PDF> [Accessed 8 Mar 2019].
4. Food and Agriculture Organisation of the United Nations. The power of pollinators: why more bees means better food: how bees impact



- nutrition and why and how to preserve them. Available: <http://www.fao.org/zhc/detail-events/en/c/428504> [Accessed 8 Mar 2019].
5. European Commission, Agriculture and rural development. Beekeeping and honey. Available: [https://ec.europa.eu/agriculture/honey\\_en](https://ec.europa.eu/agriculture/honey_en) [Accessed 8 Mar 2019].
  6. European Commission, Agriculture and rural development. Eu honey market situation in 2017. Available: [https://ec.europa.eu/agriculture/sites/agriculture/files/honey/market-presentation-honey\\_en.pdf](https://ec.europa.eu/agriculture/sites/agriculture/files/honey/market-presentation-honey_en.pdf) [Accessed assessed on 8 March 2019].
  7. Chauzat MP, Cauquil L, Roy L, *et al.* Demographics of the European Apicultural industry. PLOS one, 2013. Available: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0079018> [Accessed 8 Mar 2019].
  8. World Organisation for Animal Health (OIE). Health problems of bees are due to multiple factors, 2010. Available: <http://www.oie.int/en/for-the-media/press-releases/detail/article/health-problems-of-bees-are-due-to-multiple-factors/> [Accessed 8 Mar 2019].
  9. Tabajdi CS. Report on honeybee e health and the challenges of the beekeeping sector (2011/2108(INI)) Committee on Agriculture and Rural Development Rapporteur, 2011. Available: <http://www.europarl.europa.eu/sides/getDoc.do?type=REPORT&reference=A7-2011-0359&language=EN> [Accessed 8 Mar 2019].
  10. Erdős N. Report on prospects and challenges for the EU apiculture sector (2017/2115(INI)) Committee on Agriculture and Rural Development Rapporteur. Available: <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+REPORT+A8-2018-0014+0+DOC+XML+V0/EN> [Accessed 8 Mar 2019].
  11. European Commission. Eu efforts for bee health. Available: [https://ec.europa.eu/food/animals/live\\_animals/bees/health\\_en](https://ec.europa.eu/food/animals/live_animals/bees/health_en) [Accessed assessed on 8 March 2019].
  12. European week of bees and pollination, 2014. Available: <https://ec.europa.eu/jrc/en/science-update/european-week-bees-and-pollination> [Accessed 8 Mar 2019].
  13. The 2018 European Week of Bees and Pollination, 2018. Available: <http://www.beeweek.eu/> [Accessed 8 Mar 2019].
  14. Federation of Veterinarians of Europe. Tackling Europe's bee decline: The role veterinarians can play. Available: <https://www.fve.org/cms/wp-content/uploads/Bees-Brochure-EN.pdf> [Accessed 8 Mar 2019].
  15. EFTA. European free trade association, 2018. Available: [www.efta.int](http://www.efta.int) [Accessed 8 Mar 2019].
  16. EAEVE. European association of establishments of veterinary education, 2019. Available: <http://www.eaave.org> [Accessed 8 Mar 2019].
  17. FVE. Federation of veterinarians of Europe, 2019. Available: <https://www.fve.org> [Accessed 8 Mar 2019].
  18. Iatridou D, Nagy Z, De Briyne N, *et al.* Mapping the teaching of laboratory animal science and medicine in the European Union and European free trade area. *J Vet Med Educ* 2018;45:556–66.
  19. Iatridou D, Pohl L, De Briyne N, *et al.* Mapping the teaching of aquatic animal veterinary medicine in the European Union and European free trade area. *Vet Rec Open* 2018;5:e000309.
  20. EAEVE. Self-Evaluation report and visitation report of visited establishments., 2019. Available: <http://www.eaave.org/esevt/ser-and-visitation-report-of-visited-establishments.html> [Accessed 8 Mar 2019].
  21. EAEVE. European system of evaluation of veterinary training (ESEVT), 2019. Available: <http://www.eaave.org/esevt/sop.html> [Accessed 8 Mar 2019].
  22. ENQA. European association for quality assurance in higher education, 2019. Available: <https://enqa.eu/> [Accessed 8 Mar 2019].
  23. EAEVE. The establishments' status after the ECOVE meeting held on 17 may 2017, 2017. Available: [https://www.eaave.org/fileadmin/downloads/establishments\\_status/EAEVE\\_Establishments\\_Status\\_November\\_2017\\_approved\\_by\\_ExCom\\_on\\_29.01.2018.pdf](https://www.eaave.org/fileadmin/downloads/establishments_status/EAEVE_Establishments_Status_November_2017_approved_by_ExCom_on_29.01.2018.pdf) [Accessed 8 Mar 2019].
  24. Spector MJ, Merrill DM. Handbook of research on educational communication, 2014. Available: <http://members.aect.org/edtech/ed1/41/41-01.html> [Accessed 8 Mar 2019].
  25. EU Publications. Treaty of Lisbon, 2019. Available: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:C:2007:306:TOC> [Accessed 8 Mar 2019].
  26. EUR-Lex. Glossary of summaries: Subsidiarity, 2019. Available: <http://eur-lex.europa.eu/summary/glossary/subsidiarity.html> [Accessed 8 Mar 2019].
  27. European Committee of Regions. Subsidiarity monitoring in the area of education, vocational training and youth, 2019. Available: <https://portal.cor.europa.eu/subsidiarity/policyareas/Pages/Education.aspx> [Accessed 8 Mar 2019].
  28. EUR-Lex. Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the recognition of professional qualifications, 2019. Available: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005L0036&from=EN> [Accessed 8 Mar 2019].
  29. EUR-Lex. Directive 2013/55/EU of the European Parliament and of the Council of 20 November 2013 amending Directive 2005/36/EC on the recognition of professional qualifications and Regulation (EU) No 1024/2012 on administrative cooperation through the Internal Market Information System ('the IMI Regulation'), 2019. Available: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013L0055&from=EN> [Accessed 8 Mar 2019].
  30. EUR-Lex. Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ('Animal Health Law'), 2019. Available: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2016:084:TOC> [Accessed 8 Mar 2019].
  31. EUR-Lex. Regulation (EU) 2019/6 of the European Parliament and of the Council of 11 December 2018 on veterinary medicinal products and repealing Directive 2001/82/EC, 2019. Available: <https://eur-lex.europa.eu/eli/reg/2019/6/oj> [Accessed assessed on 8 March 2019].
  32. EUR-Lex. Official controls regulation (EU) 2017/625, 2018. Available: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R0625&from=EN> [Accessed 8 Mar 2019].
  33. ECCVT. Statement on Day One Competences & Annex V of Directive 2013/55, 2019. Available: [http://old.fve.org/education/docs\\_to\\_download/ECCVT%20Newsletter/Other%20activities/2015\\_2%20D1C\\_Adopted.pdf](http://old.fve.org/education/docs_to_download/ECCVT%20Newsletter/Other%20activities/2015_2%20D1C_Adopted.pdf) [Accessed 8 Mar 2019].
  34. EUR-Lex. Council Directive 92/65/EEC of 13 July 1992 laying down animal health requirements governing trade in and imports into the community of animals, semen, ova and embryos not subject to animal health requirements laid down in specific community rules referred to in Annex A (I) to Directive 90/425/EEC, 2019. Available: <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31992L0065> [Accessed 8 Mar 2019].
  35. World Trade Organization (WTO). The agreement on the application of sanitary and phytosanitary measures. WTO, Geneva, 1995. Available: [www.wto.org/english/tratop\\_e/sps\\_e/spsagr\\_e.htm](http://www.wto.org/english/tratop_e/sps_e/spsagr_e.htm) [Accessed 8 Mar 2019].
  36. FVE. Code of conduct, . 2012. Available: [https://www.fve.org/cms/wp-content/uploads/bro\\_fve\\_2009\\_final-1.pdf](https://www.fve.org/cms/wp-content/uploads/bro_fve_2009_final-1.pdf) [Accessed assessed on 8 March 2019].
  37. ECCVT paper. Harmonisation of veterinary education: fundamental for establishing EU citizens' trust in veterinary services. Available: [http://old.fve.org/education/docs\\_to\\_download/2015\\_1%20Position%20on%20ESEVT%20FINAL.pdf](http://old.fve.org/education/docs_to_download/2015_1%20Position%20on%20ESEVT%20FINAL.pdf) [Accessed 8 Mar 2019].
  38. EAEVE. ESEVT standard operating procedure (SOP) as Approved at the Uppsala EAEVE General assembly on 12 may 2016, 2019. Available: [http://www.eaave.org/fileadmin/downloads/SOP/ESEVT\\_Uppsala\\_SOP\\_May\\_2016.pdf](http://www.eaave.org/fileadmin/downloads/SOP/ESEVT_Uppsala_SOP_May_2016.pdf) [Accessed 8 Mar 2019].
  39. European Horse network. The horse and veterinary medicinal products, 2015. Available: <http://www.europeanhorsenetwork.eu/app/download/15045662/Veterinary+Products.pdf> [Accessed 8 Mar 2019].
  40. FVE. FishMedPlus: gap analysis outcome final, 2017. Available: <https://www.fve.org/cms/wp-content/uploads/Gap-Analysis-Outcome-Final2.pdf> [Accessed 8 Mar 2019].
  41. European Medicines Agency. Report from the workshop on medicines for bees - What the Agency can do to increase availability 14 - 15 December 2009, London, 2009. Available: [https://ec.europa.eu/food/sites/food/files/animals/docs/la\\_beves\\_vet-issues\\_ema\\_conclusions.pdf](https://ec.europa.eu/food/sites/food/files/animals/docs/la_beves_vet-issues_ema_conclusions.pdf) [Accessed 8 Mar 2019].
  42. EUR-Lex. Regulation (EU) 2018/470 of 21 March 2018 on detailed rules on the maximum residue limit to be considered for control purposes for foodstuffs derived from animals which have been treated in the EU under article 11 of Directive 2001/82/EC, 2019. Available: <https://eur-lex.europa.eu/legal-content/GA/TXT/?uri=CELEX:32018R0470> [Accessed 2 Jul 2019].
  43. AVMA. Drugs for honeybee disease will require veterinary prescription in 2017, 2019. Available: <https://www.avma.org/News/JAVMANews/Pages/161015a.aspx> [Accessed 8 Mar 2019].
  44. CVMA. Treating honey bees and pollinators: what veterinary medical professionals need to know, 2018. Available: <https://www.canadianveterinarians.net/documents/treating-honey-bees-and-pollinators-what-veterinary-medical-professionals-need-to-know> [Accessed 8 Mar 2019].
  45. Manitoba agriculture. Recommendations for administering antibiotics and acaricides to honey bees, 2017. Available: <https://www.gov.mb.ca/agriculture/crops/production/pubs/administering-antibiotics-and-acaricides-to-honey-bees.pdf> [Accessed 8 Mar 2019].
  46. Reybroeck W, Daeseleire E, De Brabander HF, *et al.* Antimicrobials in beekeeping, 2012. Available: <https://www.sciencedirect.com/science/article/pii/S0378113512000326> [Accessed 8 Mar 2019].



47. EUR-Lex. Commission regulation (EU) NO 206/2010 of 12 March 2010 laying down Lists of third countries, territories or parts thereof authorised for the introduction into the European Union of certain animals and fresh meat and the veterinary certification requirements, 2019. Available: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02010R0206-20130528&rid=4> [Accessed 8 Mar 2019].
48. OIE forum. Ritter W. bee diseases are a worldwide problem, 2014. Available: <http://oie.int/doc/ged/D13697.PDF> [Accessed 8 Mar 2019].
49. EUR-Lex. Council Directive 2001/110/EC of 20 December 2001 relating to honey, 2019. Available: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32001L0110> [Accessed 8 Mar 2019].
50. EUR-Lex. Commission regulation (EU) NO 37/2010 of 22 December 2009 on pharmacologically active substances and their classification regarding maximum residue limits in foodstuffs of animal origin (text with EEA relevance), 2019. Available: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010R0037> [Accessed 8 Mar 2019].
51. EUR-Lex. Regulation (EC) NO 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC Text with EEA relevance, 2019. Available: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32005R0396> [Accessed 8 Mar 2019].
52. European Commission. EU pesticide database, 2019. Available: <http://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=homepage&language=EN> [Accessed 8 Mar 2019].
53. One Health global Network. What is one health? 2019. Available: <http://www.onehealthglobal.net/what-is-one-health> [Accessed 8 Mar 2019].
54. Ritter W OIE. Bee health and veterinarians, 2014. Available: <http://www.oie.int/en/for-the-media/press-releases/detail/article/veterinarians-key-players-in-preserving-bee-health/> [Accessed 8 Mar 2019].
55. Vanbergen AJ, Initiative theIP. Threats to an ecosystem service: pressures on pollinators. *Front Ecol Environ* 2013;11:251–9.
56. Van der Zee R, Brodschneider R, Brusbardis W, *et al.* Results of international standardised beekeeper surveys of colony losses for winter 2012–2013: analysis of winter loss rates and mixed effects modelling of risk factors for winter loss. *J Apic Res* 2014;53:19–34.
57. Steinhauer NA, Rennich K, Wilson ME, *et al.* A national survey of managed honey bee 2012–2013 annual colony losses in the USA: results from the bee informed partnership. *J Apic Res* 2014;53:1–18.
58. Lee KV, Steinhauer NA, Rennich K, *et al.* A national survey of managed honey bee 2013–2014 annual colony losses in the USA. *Apidologie*. 2015; 46:292±305. Available: <https://link.springer.com/article/10.1007%2Fs13592-015-0356-z> [Accessed 8 Mar 2019].
59. Vidal-Naquet N, Roy C, OIE forum. The veterinary profession: an asset to the bee-keeping sector, 2014. Available: <http://oie.int/doc/ged/D13700.PDF> [Accessed 8 Mar 2019].
60. Bruckner S, Steinhauer N, Rennich K, *et al.* Honey bee colony losses 2017–2018: preliminary results, 2018. Available: <https://beeinformed.org/results/honey-bee-colony-losses-2017-2018-preliminary-results> [Accessed 8 Mar 2019].
61. Le Conte Y, Navajas M. Climate change: impact on honey bee populations and diseases. *Revue scientifique et technique (International office of Epizootics)*. 27. 485–97, 499. 2018, 2008. Available: <https://doc.oie.int/dyn/portal/index.seam?page=alo&alold=30769> [Accessed 2 Jul 2019].
62. Jacques A, Laurent M, Ribière-Chabert M, *et al.* A pan-European epidemiological study reveals honey bee colony survival depends on beekeeper education and disease control. *PLoS One*;12:e0172591.2017.
63. FVE. Position on continuous professional development, 2018. Available: <https://www.fve.org/cms/wp-content/uploads/FVE-position-on-Continuous-Professional-Development.pdf> [Accessed 8 Mar 2019].
64. European board of veterinary specialisation: EBVS, 2018. Available: <http://ebvs.eu> [Accessed 8 Mar 2019].
65. EBVS. Colleges, 2019. Available: <https://ebvs.eu/colleges> [Accessed 8 Mar 2019].
66. VETCEE. Veterinary continuous education in Europe, 2019. Available: <https://www.fve.org/vetcee> [Accessed 8 Mar 2019].
67. UEVP. Union of European veterinary practitioners, 2019. Available: <https://www.fve.org/uevp> [Accessed 8 Mar 2019].