[1]Diana White, [2]Gerda de Vries, [1]Jonathan Martin,
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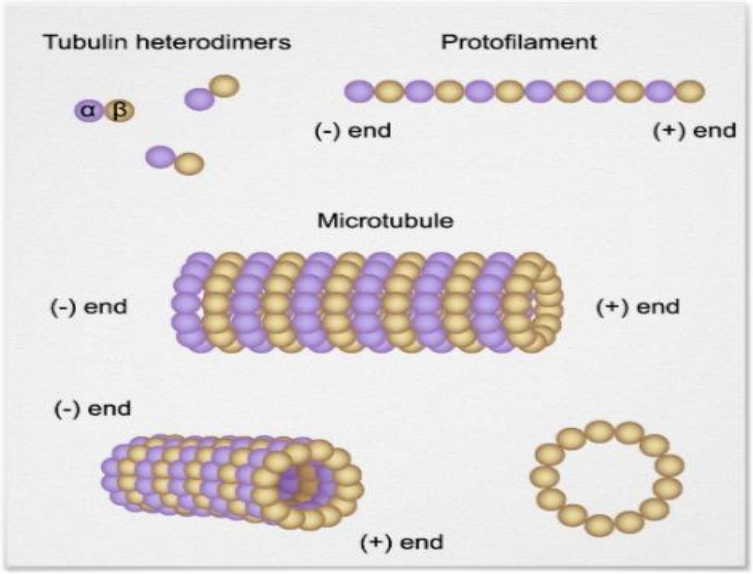
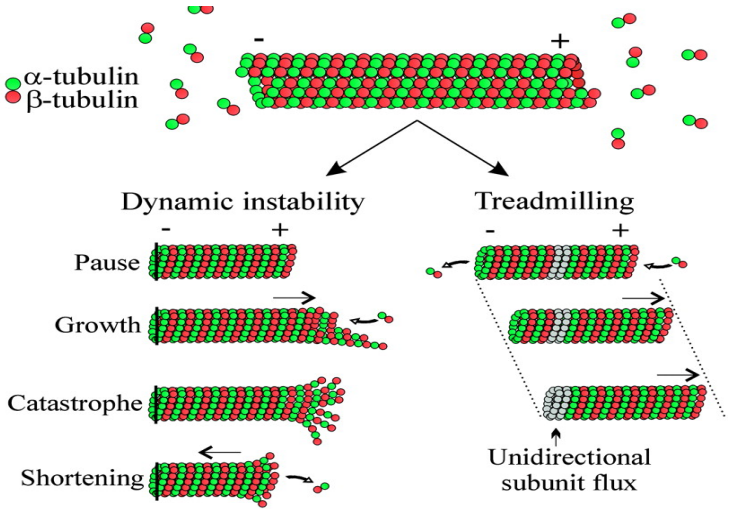
[3]Ohio State University, USA

Microtubule patterning in the presence of motor proteins

Microtubule (MT) structure and dynamics

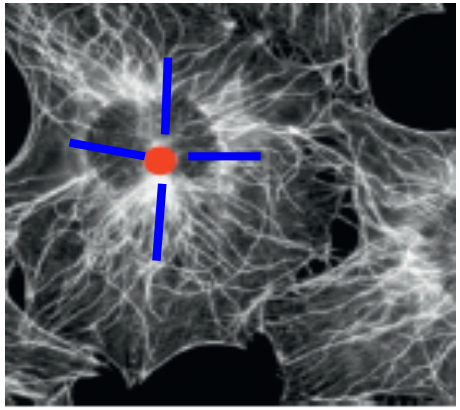


Typical MT structure

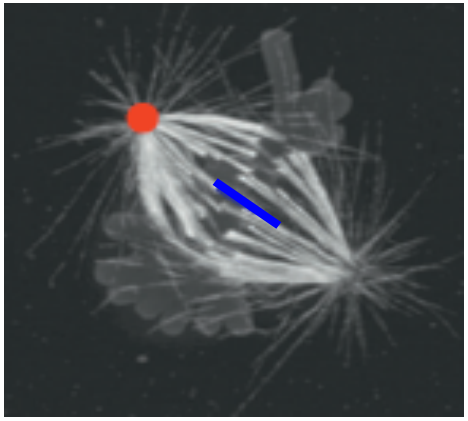


Typical MT dynamic properties

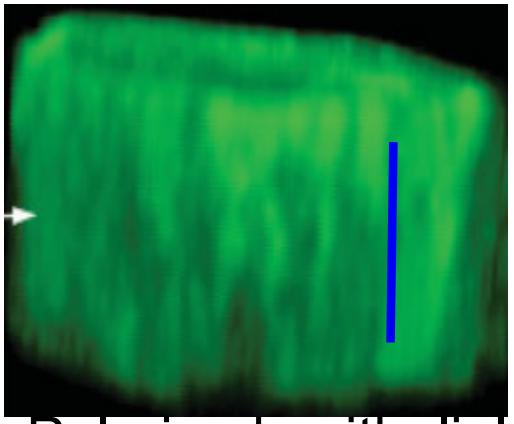
Microtubule organization *in vivo*



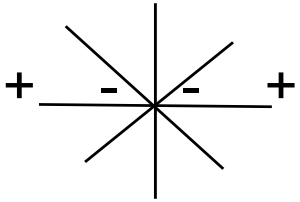
Fibroblast [1]



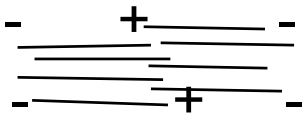
Typical dividing cell [1]



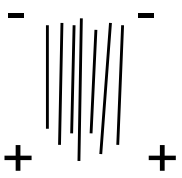
Polarized epithelial cell [2]



Aster

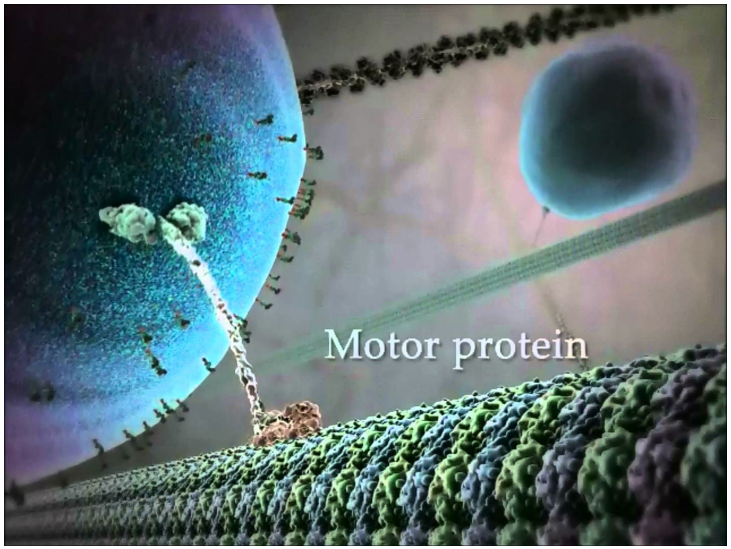


Anti-parallel bundle

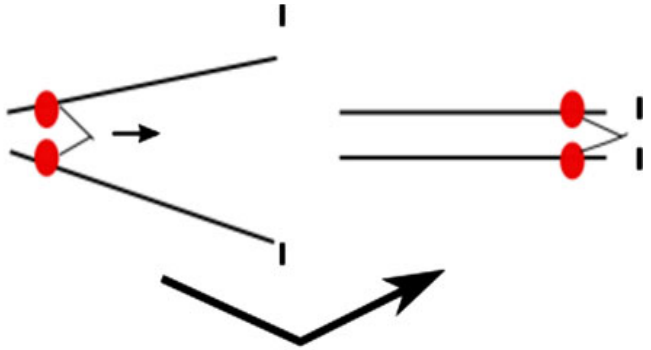


Parallel bundle

Motor proteins and MTs

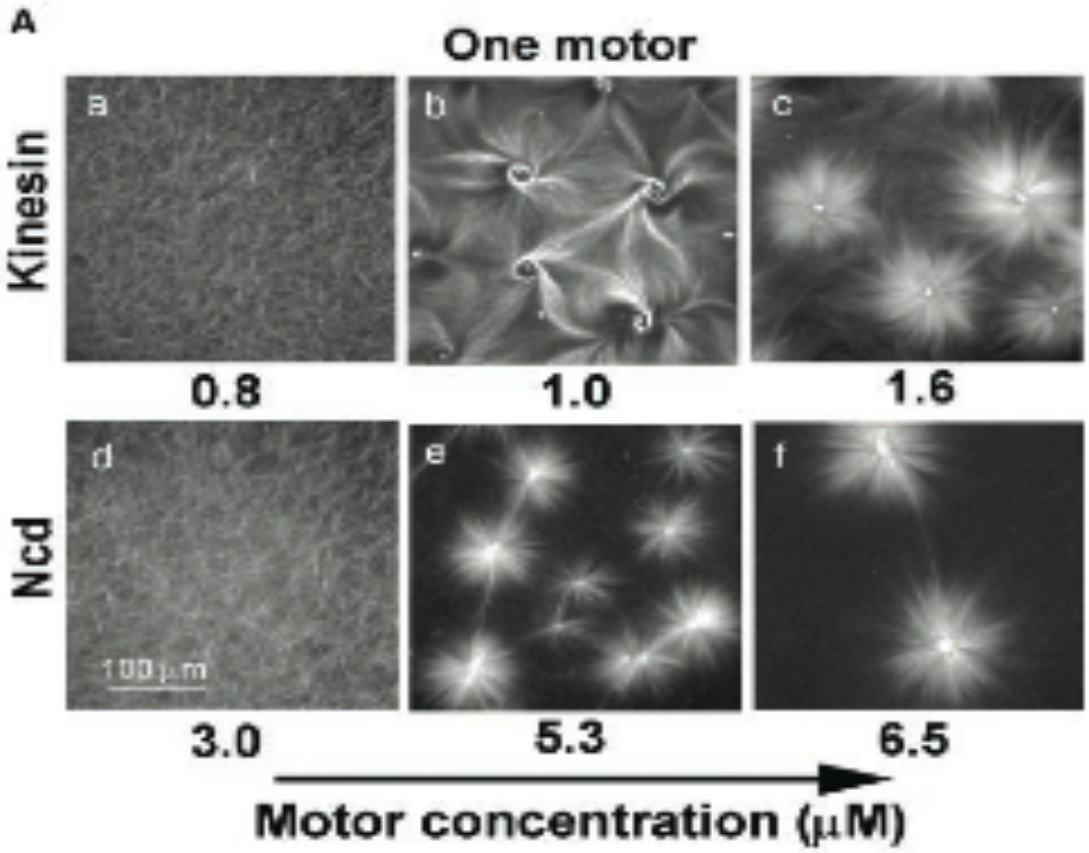


Motor proteins walk along MTs



Motor proteins aling MTs
(produce force)

Microtubule organization *in vitro*



Experiments by Surrey and Nedelec 2001

Bull Math Biol
DOI 10.1007/s11538-014-9991-1

Society for Mathematical Biology

ORIGINAL ARTICLE

(1)

Microtubule Patterning in the Presence of Stationary Motor Distributions

Diana White · Gerda de Vries · Adriana Dawes

(2)

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D White, G de Vries, J Martin, and A Dawes
Journal of Theoretical Biology, 2015

(3)

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Bound motors walk along MTs

$$\frac{\partial m_b(x,t)}{\partial t} + v_b \cdot \nabla_x (m_b(x,t)) = k_{on}(\tilde{p}) m_u(x,t) - k_{off} m_b(x,t)$$

Unbound motors diffuse freely

motors switch between bound and unbound states

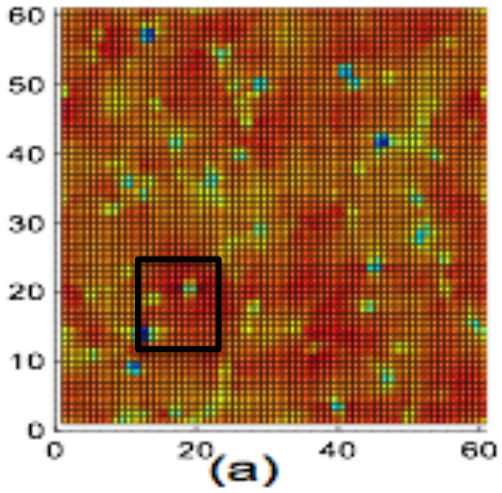
$$\frac{\partial m_u(x,t)}{\partial t} - D_u \Delta_x m_u(x,t) = -k_{on}(\tilde{p}) m_u(x,t) + k_{off} m_b(x,t)$$

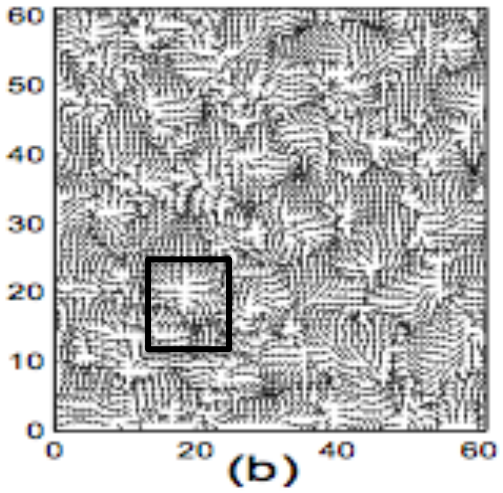
$$\frac{\partial p(x,t,\theta)}{\partial t} + S_{MT}\hat{\theta} \cdot \nabla_x p(x,t,\theta) = -\lambda(m_b) p(x,t,\theta) + \lambda(m_b) \int_{-\pi}^{\pi} k(\theta,\tilde{\theta},m_b) p(x,t,\theta) d\tilde{\theta}$$

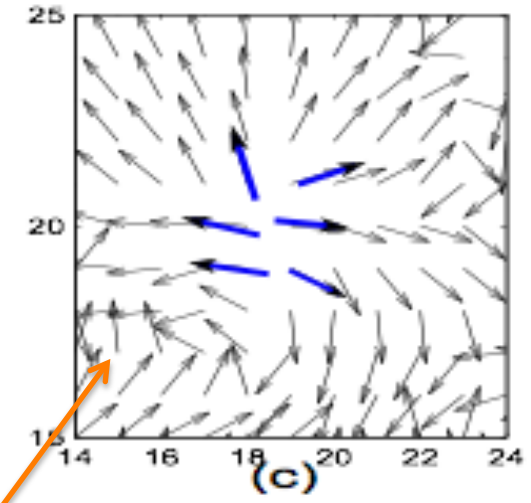
MTs treadmill along a directed path

MTs reorganize in the presense of motor proteins

Simulation result for NCD (low motor density)

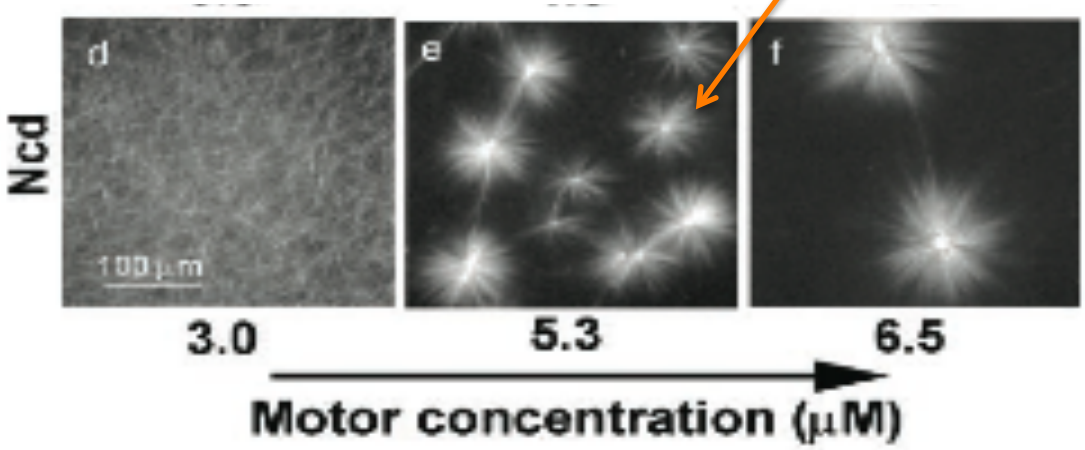




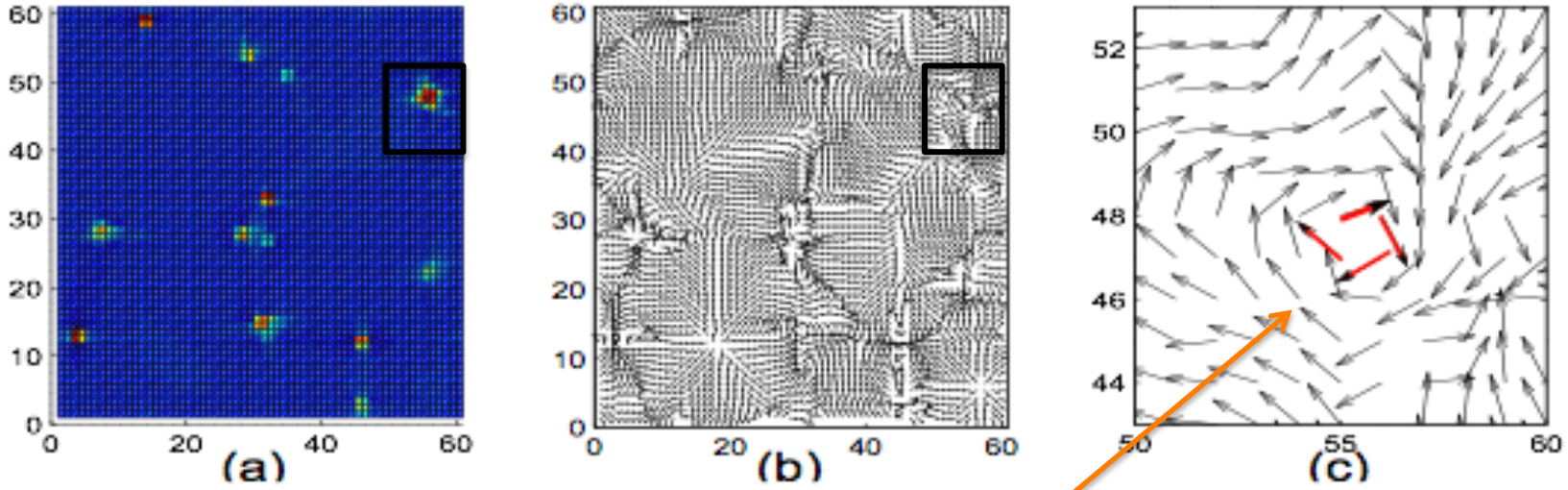


MT density

MT orientation

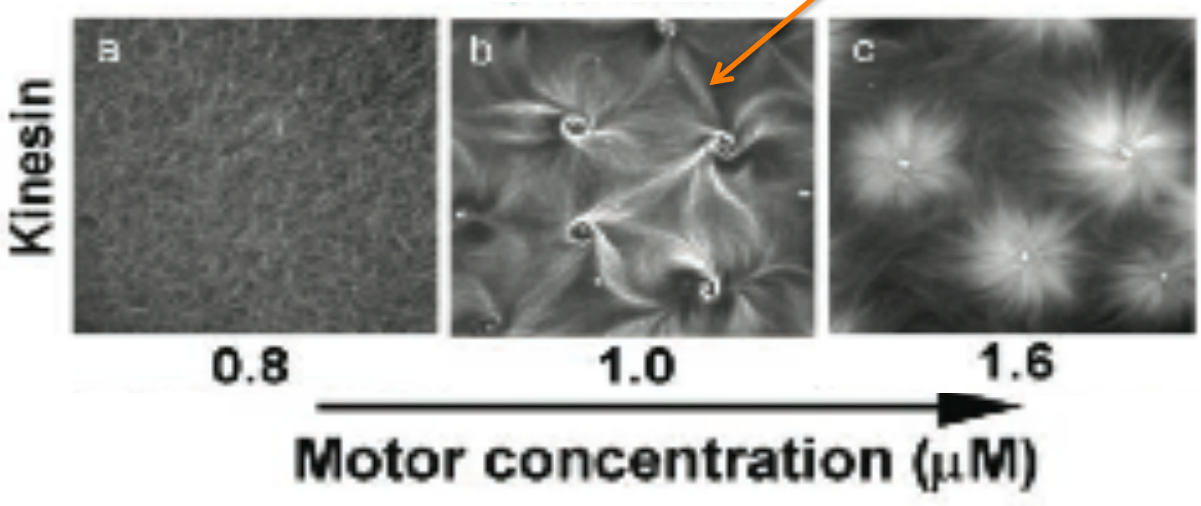


Simulation result for kinesin (low motor density)

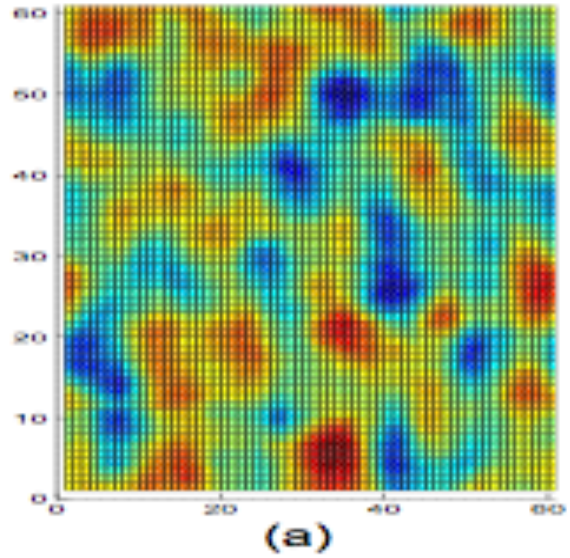


MT density

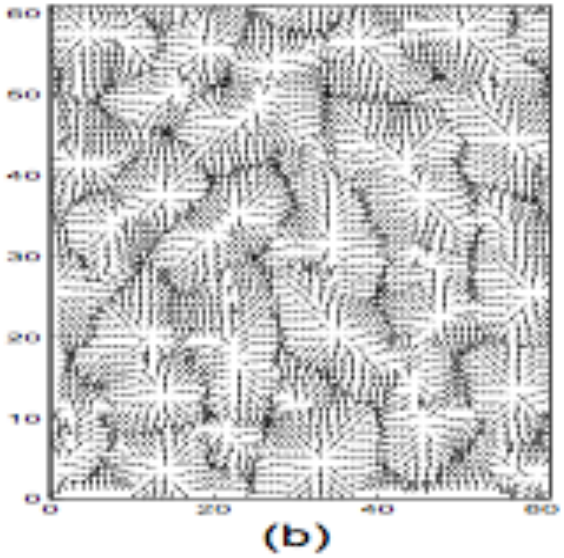
MT orientation

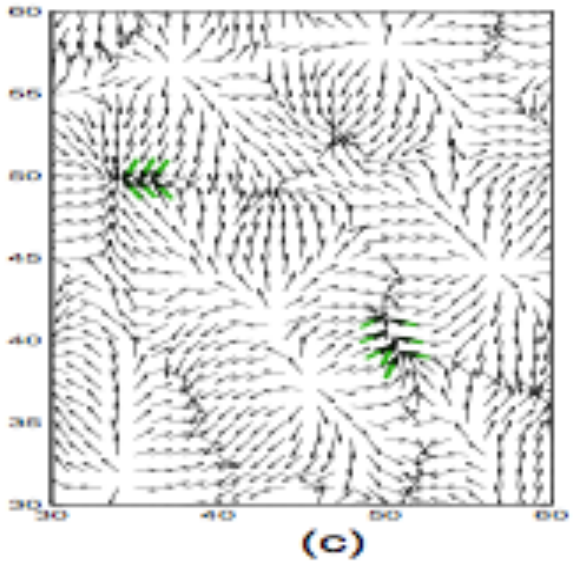


Results with two opposing mitotic motors (kinesin-5 and NCD)



MT density





MT orientation

Conclusions and future work

- We can reproduce patterns found in *in vitro* experiments.
- We can produce anti-parallel bundles (like in the mitotic spindle!).
- We have developed a nice E and U result (T Hillen *et al*. Submitted to SIAP).
- Next, we include dynamic instability and look at action of chemotherapy drugs on MT organization (in particular, the anti-parallel bundles).